JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOLUME 14, 1924

PUBLISHED SEMI-MONTHLY
EXCEPT IN JULY, AUGUST, AND SEPTEMBER, WHEN MONTHLY
BY THE
WASHINGTON ACADEMY OF SCIENCES

WILLIAMS & WILKINS COMPANY
BALTIMORE, MD., U. S. A.

ERRATA

Vol. 14, 1924

Page 55: The papers by C. E. Van Orstrand and by A. L. Day and E. T. Allen were given at the 370th meeting, not at the 371st as stated in the Proceedings.

Page 78, line 11: For Dr. HILLEBRAND read Dr. H. S. WASHINGTON.

Page 205, line 6 from bottom: For Arizona read New Mexico.

Page 399, in the formula, line 13 from bottom: For $1 + \cos a$ read $1 - \cos a$.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 14 JANUARY 4, 1924 No. 1

THE FOSSIL SWAMP DEPOSIT AT THE WALKER HOTEL SITE, CONNECTICUT AVENUE AND DE SALES STREET, WASHINGTON, D. C.[1]

FORMATIONS EXPOSED IN THE EXCAVATION

CHESTER K. WENTWORTH, GEOLOGICAL SURVEY

INTRODUCTION

Early in August, 1922, S. E. Godden, publicity manager of the Allen E. Walker Organization, called the attention of the United States Geological Survey to the stumps of trees and other vegetable remains that were being brought to light in the excavation for the foundation and basement of the new Walker Hotel, located at Connecticut avenue and DeSales street, N. W., Washington, D. C. DeSales Street is an east-west street, only one block long, about half way between L and M streets and between Seventeenth street and Connecticut avenue. The excavation is about 450 feet long and 150 feet wide.

The writer, who at the time was engaged in a critical study of terrace phenomena in the vicinity of Washington, under the auspices of the Geological Survey, examined the section at intervals of two or three days as the work progressed, until the 15th of September, when he left the city. The following paper is based in part on the writer's personal observations and in part on notes later furnished to him by Messrs. L. W. Stephenson and Laurence La Forge, during the continued progress of the work. Samples of the different formations were collected, but these have not as yet been critically studied in the laboratory.

[1] Papers presented at the 176th meeting of the Washington Academy of Sciences held jointly with the Geological Society of Washington, the Biological Society of Washington, and the Botanical Society of Washington, the evening of Wednesday, March 14, 1923.

The writer is indebted to Mr. Godden, to F. F. Gillen, engineer in charge of the excavation, and to several of the workmen for courtesies and assistance rendered during his examination of the section.

The present surface of the ground at the block bounded by Seventeenth and Connecticut avenue and DeSales street and L street has an altitude of 50 to 57 feet above sea level. The depth of the excavation for the foundation of the hotel was 35 to 40 feet, making the range of altitude of the bottom of the cut 15 to 22 feet above sea level.

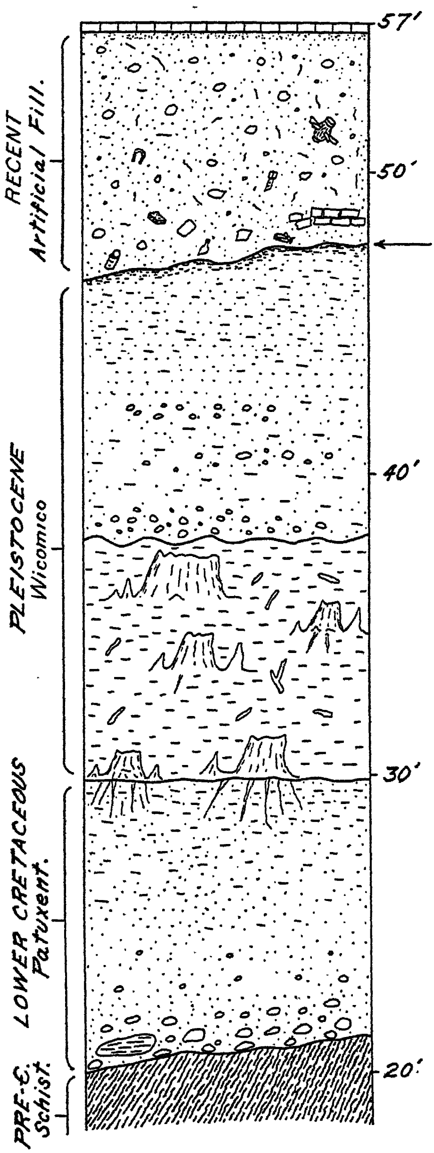
THE SECTION

Five different formations were exposed in the section afforded by the excavation, the thicknesses and general relations of which are shown in the generalized columnar section (Fig. 1). These formations from above downward were as follows:

(1) Artificial fill.
(2) Pleistocene loam, sandy clay, sand, and gravel.
(3) Pleistocene swamp silt or muck.
(4) Cretaceous sand and gravel.
(5) Pre-Cambrian schist.

DESCRIPTION OF FORMATIONS

Artificial fill. This material consists of a mixture of loam, clay, and sand, and varies in thickness from nothing at the northeast corner of the excavation to a maximum of 13 feet near the middle of the west side, the difference in thickness being due to the irregular configuration of the original surface on which the material was dumped. The material is likewise somewhat variable in composition and has little regularity of structure. Overlapping of different phases indicates the shifting of sources of the material dumped and of the directions of accumulation. Various materials of human source, while not quantitatively of great importance, are sufficiently abundant to indicate deposition of the material contemporaneously with the activities of civilized man. The shapes and conditions of fragments of these materials together with the crude non-stratified character of the deposit show conclusively that it is artificial fill. Bits of coal, brick, tile and other pottery, tin cans, oyster shells, and occasional fragments of glass, leather, and metals are the most abundant relics found in this formation. A brick pavement, said to have been part of the cellar floor of the old convent which stood at the west end of the hotel site, and an old stone wall, extending two or three feet below the base of the fill, were exposed along the west side of the excavation.



Brick sidewalk at present street grade.

Unassorted mixture of gravel, loam, and clay. Contains a variety of articles of human source, such as bricks, tile, coal, cinders, glass, tin cans, and metal and leather fragments. 0 ft. to 13 ft.

Peat—a thin layer of carbonaceous material at the contact between the fill and the underlying sandy loam. 0 in. to 0.5 in.

Light gray loam, sandy clay, sand, and gravel, in places slightly mottled with buff. The material is poorly assorted and includes bands and lenses of pebbly sand. Wicomico formation. 5 ft. to 15 ft.

Light brown highly carbonaceous silt or swamp muck, containing tree stumps and wood fragments; turns black when exposed to air. 6 ft. to 9 ft.

Clay, sand, and gravel. Ranges from sandy clay above to coarse gravel at the base; finer material is a rich micaceous, little assorted gray-green geest from the underlying schist; the pebbles of the gravel are composed of a great variety of rocks from many parts of the Potomac basin, and the gravel is far less dominantly quartzose than the Pleistocene gravels of this region. The deposit is a basal phase of the Patuxent formation. 7 ft. to 12 ft.

Schist, considerably weathered but still compact.

Fig. 1. Generalized columnar section of formations exposed in the excavation.

Pleistocene loam, sandy clay, and gravel. At the top of this layer is a thin carbonaceous or peaty band containing small fragments of vegetable material. This band is an inch or less in thickness and is absent in some places; it is underlain by a soil zone 6 to 12 inches thick.

The main body of this layer below the soil zone includes gray to buff sandy clay and loam, and subordinate sand and gravel beds alternating with little order with respect to the top or the base of the section. The bedding, so far as observed by the writer, was of the cut-and-fill type, with stringers and zones of pebbles such as are common in the Pleistocene terrace deposits. The pebbles are dominantly of quartzite and vein quartz with a small amount of chert. The sand is almost wholly composed of quartz grains; ilmenite is present to the extent of perhaps one per cent, with muscovite and other minerals in much less abundance. The base of the formation grades into the swamp muck below, the contact being uneven, due apparently to differential leaching or perhaps to uneven deposition.

Though considerable search was made on several occasions by the writer and others, no brick, coal, cinders or other trash was found in this layer and there was no indication whatever that it was formed artificially or even contemporaneously with human occupation of the region.

Pleistocene swamp muck. The material next below the Pleistocene clay, sand, and gravel is of exceptional interest because of the unusual amount of fossil wood it contains, and is the subject of the great attention which the Walker Hotel section has commanded among scientists and residents of the city generally. The muck is 6 to 9 feet thick and underlies the entire hotel site. When first uncovered it is a light brown, highly carbonaceous clay containing in places considerable sand and many mica flakes from underlying formations. Within a minute or two after exposure to the air the material turns very dark, almost black.

The wood is present in the form of many huge stumps, upright and in place, and broken fragments of limbs and roots. The largest stump measured by the writer was about 8 feet in diameter but others considerably larger are reported. Most of the wood is cypress and appears to differ, in no essential respect from the common bald cypress, *Taxodium distichum.* In addition to the cypress wood, which includes stumps, roots, knees, and a few logs, numerous seeds and leaves of cypress were found. The seeds of other plants also occur, but these are less common than the cypress. Little alteration of the wood has taken place. It is water-soaked when first dug out and checks on

drying, becoming a little harder and firmer, but not "hard as iron" as has been reported. Like the green wood of recent cypress this fossil wood becomes very light in weight when dried. The stumps are rudely truncated at the top in an irregular but not splintery fashion. This abrupt upper termination appears to be due to subaerial rotting at or near the surface of continuous soil moisture, such as affects posts and poles erected by man. Likewise the scarcity of great trunks seems to be explicable by the rotting which usually takes place before burial is accomplished. Apparently only the smaller limbs, the stumps, and portions of a few larger trunks were buried or submerged in time to be preserved. No one has observed an authentic ancient axe mark on any of the stumps, and there is nothing in their appearance to warrant the popular opinion that the trees were cut down by man.

As the swamp deposit is 6 to 9 feet thick there is room for at least three stumps, one above the other, and as the individual trees must have lived 200 years or more, the time required for the deposition of the swamp muck must have been at least 600 years and may have been a thousand years.

Fossil remains of microscopic fresh water plant organisms, known as diatoms, are present in great numbers in the muck and they represent many different species.

Lower Cretaceous sand and gravel, Patuxent formation. Beneath the swamp muck is micaceous clay silt, which grades downward to sand and gravel. This formation is penetrated in its upper part by the roots and rootlets extending downward from the tree stumps preserved in the overlying formation; some of the roots extend 3 or 4 feet below the base of the swamp deposit. The finer portions of the Patuxent formation are almost wholly derived with little sorting from the weathered detritus of the underlying schist. The sands consist of angular grains of quartz, mica, garnet, tourmaline, hornblende, epidote, titanite, ilmenite, and other minerals, rudely assorted as to size, but clearly the product of very limited transportion, probably a few rods at most.

The gravel likewise contains angular blocks of the schist, though these are fragile and could not have been carried far. On the other hand, the bulk of the pebbles and boulders of the gravel, some of which range up to two feet or more in diameter, are of rocks foreign to the immediate vicinity.

G. W. Stose and Miss A. I. Jonas have very kindly made annotated identifications of the pebbles of a collection from this formation. On

the basis of these identifications the following composition was determined by the writer for 423 pebbles of diameters ranging from 8 to 16 millimeters:

	No. of pebbles
Vein quartz	109
Harpers schist	79
Chert, black and gray	63
Cambrian quartzite	64
Chloritic vein quartz	37
Epidotic greenstone, amygdaloidal	23
Triassic sandstone	13
Gray Weverton quartzite	13
Wissahickon schist	11
Garnetiferous and other granite	5
Sericitic quartzite	1
Hematitic Weverton sandstone	2
Pre-Cambrian apo-rhyolite	3
Total	423

It is apparent from this list that the sources of the pebbles of the gravel are widespread over the Potomac basin and that transportation must have been comparatively rapid and weathering relatively slight during the epoch of its origin.

Pre-Cambrian schist. This ancient rock is a highly metamorphosed rock of gray-green color and schistose structure. It was clearly eroded to a relatively plane surface before the deposition of the overlying gravel but not all the weathered rock was removed at that time. At the surface, which was the only part seen by the writer, it is moderately compact and serves as an adequate basement for the heavy concrete walls and foundation, though it can be picked and wedged loose with a pick or hammer.

AGE RELATIONS OF THE FORMATIONS

The uppermost of the five formations is generally recognized by all observers to be of artificial origin and of very recent date. The persistent correlation of the tree stumps of the major swamp layer with the trees and swamp conditions which are remembered by some of the older inhabitants leads to the interpretation of the clay, sand, and gravel of the second formation as likewise artificial or at least of an origin contemporaneous with the growth of the modern city. The writer is convinced that this correlation and the consequent interpretation are wholly erroneous. He considers that the recent surface with

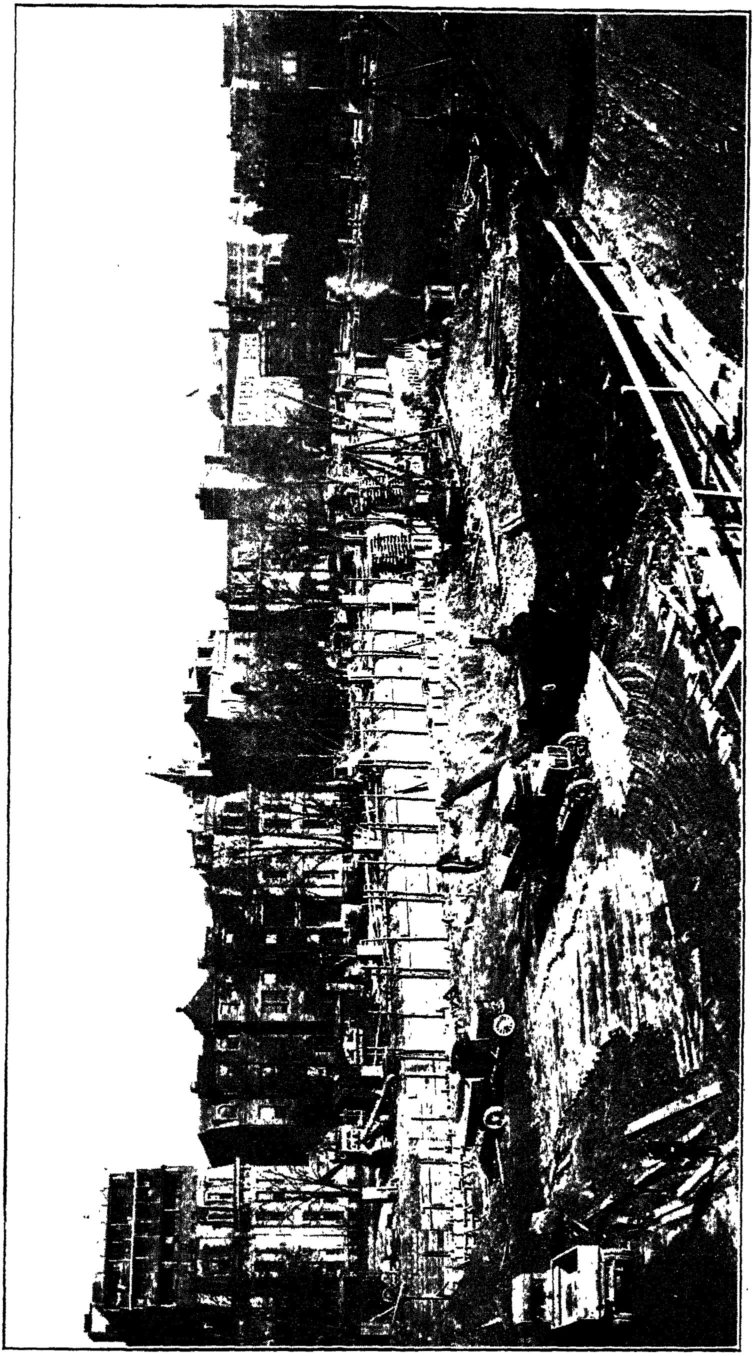


Fig. 2. General view of the east end of the Walker Hotel excavation. The steam shovel near the northeast corner is engaged in removing the materials of the Pleistocene swamp deposit, the top of which lies just below the level on which the hoisting machinery stands. Photograph reproduced by courtesy of the Walker Hotel Organization.

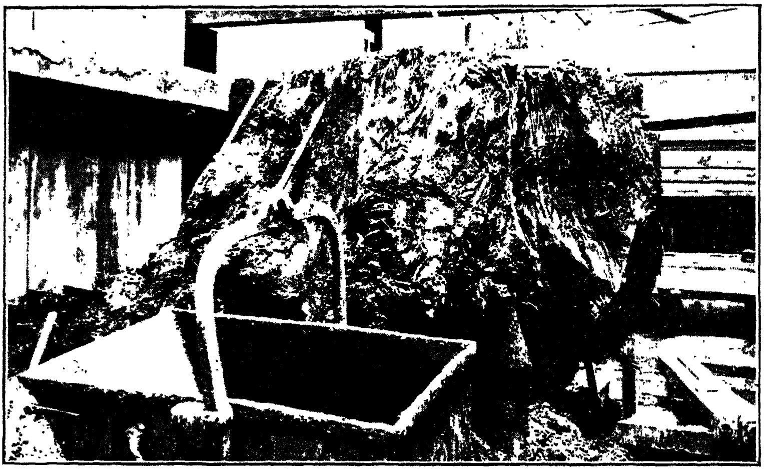


Fig. 3. One of the larger cypress stumps still in place but exposed and portions of it cut away in the process of digging. Sheet piling and one of the loading buckets are also prominent in the picture.

Fig. 4. One of the large cypress stumps from the Walker Hotel excavation, after it had been uncovered and lifted to the surface. By courtesy of the Walker Hotel Organization.

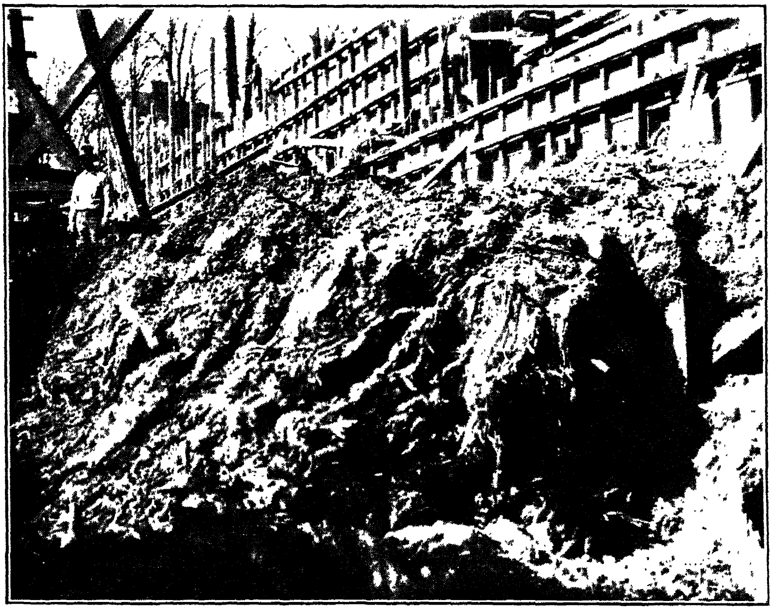


Fig. 5. Portion of a stump and roots still in place in the swamp muck on the north side of the excavation.

Fig. 6. View showing the edge of the swamp deposit into which the steam shovel is cutting. The form of a mud covered cypress stump upright and in place in the muck is indistinctly shown just to the right of the overturned bucket.

its vegetable mantle is represented by the thin peaty layer immediately below the fill, and that the clay, sand, and gravel, which is clean and devoid of artifacts, is of Pleistocene age.

The formation which lies immediately under the artificial fill is believed to have been formed during the latter half of the Pleistocene period, that is, during the latter half of the great ice age, an opinion based on the topographic position of the formation and its relation to the terraces that have been differentiated in this region. The terrace on which the portion of the city from K street northward to Sixteenth

Fig. 7. Photograph showing the character of the Patuxent gravel. This was a source of considerable water which kept the lower part of the cut constantly wet and during the off duty periods washed the gravel and kept it clean and bright, greatly facilitating its examination for various kinds of rocks and shapes of pebbles.

and U streets is built has long been known as the Wicomico terrace, and the loam, sand, and gravel underlying the terrace surface has been known as the Wicomico formation. The swamp deposit must necessarily have been formed at least a little earlier than the Pleistocene terrace deposit that overlies it, but there is no reason to believe that it is very much older. The swamp deposit is therefore referred to the early part of the Wicomico stage of the Pleistocene epoch.

The question is frequently asked, "How long in years has it been since the fossil trees found in this swamp deposit were living trees?" This can not be answered definitely. If the swamp deposit was formed during the latter half of the ice age, it must have been many thousands of years ago. In the first press notice that was given out by the writer, the figures 20,000 or 30,000 years were mentioned. The biological evidence, however, as presented in the papers which follow this one, indicate that the climatic conditions during the formation of the swamp deposit were milder than at present. This suggests that the deposit was formed during one of the interglacial stages. If it was

formed during the last interglacial stage, the Peorian, which immediately preceded the last glacial stage, the Wisconsin, a conservative estimate of the age of the swamp would be 100,000 years, and it may be much older.

The gravel and sand deposit below the swamp layer is confidently assigned to the Patuxent formation (Lower Cretaceous) on the ground of its topographic position and lithologic character. However, no fossils have been found to corroborate this correlation. The deposit lies against the eroded edge of the Piedmont Plateau and is exposed with this relation at many places in the vicinity.

The unconformity which separates the Patuxent formation from the overlying swamp deposit represents an exceedingly long interval of time, including the Upper Cretaceous epoch, the Tertiary period, and the early part of the Quaternary period. No strata are preserved in this section which were laid down during this long interval. The unconformity which separates the Patuxent formation from the underlying basement schist represents a period of time of even greater duration than does the unconformity at the top of the Patuxent, for it includes all of Paleozoic and most of Mesozoic time.

Though in this section there is presented an unusually interesting record of the conditions and history of past ages, there is no suggestion that any part of this history was unusual or exceptional at the time. The geologist knows that slowly and surely the products of nature are wrought, and that only in the fore-shortening of such a record as the one in question does one process seem to succeed another in an abrupt manner. There is to him no problem as to "What disaster overwhelmed the vast forest and crumpled it into a solid mass of crushed wood, shearing off these big trees as a man might cut grass with a scythe?" a question recently asked by a writer in Popular Mechanics with reference to this excavation. He can only hope that less and less as years go by will these relics of catastrophism persist in the popular mind.

ORGANIC REMAINS, OTHER THAN DIATOMS, FROM THE EXCAVATION

EDWARD WILBER BERRY, THE JOHNS HOPKINS UNIVERSITY

The present imperfect contribution is, so far as I know, the first illustrated account of fruits and seeds from an American Pleistocene deposit—a much neglected field of research in this country, but one that has been cultivated with great distinction in northern and central Europe.

As at the inauguration of work of this kind in Europe, I have felt the need of adequate collections of comparative material. Herbaria are almost useless, and carpological collections like those of the seed division of the Bureau of Plant Industry or that of the Biological Survey, built up with other ends in view, are not altogether satisfactory. I take much pleasure, however, in expressing my appreciation of assistance from Edgar Brown of the former and W. L. McAtee of the latter bureau, and to E. P. Felt of Albany for his determination of *Retinodiplosis*.

The determined fossils obtained by washing a large amount of the argillaceous peaty material, carefully sorting it under water, and then drying and impregnating it with paraffin has involved an enormous amount of labor—a few ounces of prepared specimens being the result of the washing of 100 pounds of the material.

I cannot say that the results are decisively significant. The species identified represent with scarcely an exception such an assemblage as might be obtained in southern Maryland or Virginia at the present time. A substantially similar representation is to be found in the present flora of the District of Columbia, but the latter area does not include all of the species found among the fossils, and although the majority of the fossil forms do still inhabit the District several would not be likely to be present at the Walker site even though the latter had remained uninhabited.

There are recorded 28 more or less definitely named species of plants, as well as several undetermined and immature forms. Several species of galls were isolated. Of these two are figured and identified. One of these is present in great abundance. No beetle or other similar insect remains, such as are usually to be found in such deposits, were encountered, but bits of chitin and insect egg cases were present, as was also what appeared to be rodent dung.

The plants represent 19 families and include 1 gymnosperm, 8 monocotyledons, and 19 dicotyledons. Thirteen are positively determined specifically and all of these represent still existing species; 5

additional are given tentative specific names; and the balance are merely identified generically. By far the most abundant remains were those of the bald cypress, grape, elderberry, *Rubus*, and sedges. As regards variety, the sedges furnish the most abundant element, six species representing the genera *Carex*, *Scirpus*, *Cladium*, and *Dulichium* being present—*Carex* and especially *Dulichium* in great abundance; and there are in addition various unidentified remains of sedges representing *Carex*, *Scirpus*, and possibly *Cyperus*.

By far the most abundant single species represented was the bald cypress. All of the trunks, many of large size, seen in the excavation were of that species, and were present at successive levels; the peaty clays were also filled with their root systems and knees. In the washed and sorted material also the cypress was overwhelmingly represented, chiefly by seeds, there being relatively few cone scales. Pointing in the same direction was the abundance of cypress cone galls of the genus *Retinodiplosis*, and those of the cypress leaf gall of the genus *Itonida*.

Some critics, opposed to the antiquity of the deposit, have made much of the absence of prostrate logs. I have seen at least a score of similar Pleistocene swamp deposits, as well as many subfossil and recent ones, and prostrate logs are as rare in these as in the Walker deposit. They are not absent in the last and the reason for their rarity is clearly indicated by the accompanying photograph of such a log collected by Dr. Stephenson and photographed by Mr. Brown (Plate 3, fig. 1). It will be noted that this is part of a large log, the submerged portion of which was preserved, although the part exposed to the air had decayed before the growth of the deposit buried it. For other records of prostrate logs seen in the Walker deposits I am indebted to Dr. David White.

In trying to picture the environment as indicated by the plants alone, and for the moment ignoring the strictly geologic and physiographic data, it may be noted that the following, represented by fossils in this deposit, are found at the present time in swamps or marshes, or in standing and slow-moving water: *Taxodium*, *Sparganium*, *Naias*, *Carex*, *Scirpus*, *Cladium*, *Dulichium*, *Polygonum*, *Castalia*, *Ceratophyllum*, *Ranunculus*, *Vitis*, *Ampelopsis*, *Cornus*, *Leucothoë*, *Sambucus*, and *Viburnum*.

This list includes not only the majority of the species represented but nearly all that it has been possible to name specifically. Not only is this the case, but all but two of the remaining forms are species of

low woods and thickets, namely: *Chenopodium*, *Rubus*, *Prunus*, *Acalypha*, *Galium*, and *Ilex*.

Only two of the fossils may be definitely assigned to various situations. These are *Phytolacca decandra* and *Viburnum prunifolium* and both might normally be found associated with the foregoing. The plants therefore may be said to point overwhelmingly to a slow stream with seasonal or permanent ponds along its course bordered by low woods and thickets, with occasional glades. The geologic occurrence and the presence of numerous huge cypress butts prove *a priori* what has just been deduced from the seeds and fruits identified.

The species represented, as is true of aquatic and water-side plants to a greater degree than to plants of other situations, are for the most part long-lived and widely distributed species. The *Ceratophyllum* is found practically throughout North America; several occur in Europe or Asia, a further indication of antiquity; and the majority are found to range from southern Canada or New England to Florida.

Those not found in the existing flora of the District are: *Taxodium distichum*, *Naias marina*, *Scirpus lacustris*, *Cladium* sp., *Ampelopsis* sp., and *Chenopodium hybridum* (?).

Others which are extremely rare or altogether absent on the Piedmont and which are Coastal Plain species in this latitude are *Ilex opaca*, *Rubus hispidus*, *Carex intumescens*, and *Leucothoë racemosa*.

The bald cypress is preeminently a Coastal Plain species toward its present northern limits; in fact the so-called Fall Line is of considerable importance as a floral boundary in this region, as was clearly shown by Shreve in his Plant Life of Maryland.

Although it is not brought out with any great precision, a perusal of the ranges of the existing representatives of the fossils indicates that their general facies is southern rather than northern. The only form represented which might seem opposed to this interpretation rests on the validity of comparing the fossil *Chenopodium* with the existing *Chenopodium hybridum*. Nullifying this, as is pointed out under the discussion of that specimen, is the fact that almost any species of *Chenopodium* might, and occasionally does, have fruits as large as *C. hybridum*. I am therefore decidedly of the opinion that the fossil assemblage indicates slightly more genial climatic conditions than those which prevail at the present time in the District. It is conceivable that such an association might live in the District at the present time, but this southern facies and the distinctly Coastal Plain character of so many of the forms suggest that at the time they lived the Walker site was nearer sea level; or, stated another way, that

considerable areas of the present Coastal Plain were covered by the sea or penetrated by estuaries due to a much more extensive drowning of stream valleys than obtains at the present time.

With regard to the age of the deposit the decisive evidence must be that from the geological side. There were relatively few Pleistocene plants that are not still existing, and in a region such as this, situated in the middle Atlantic slope both at present and during the Pleistocene, the limits of range of the flora as a whole extend for long distances both to the northward and southward. In the absence of decisive elements the only estimate of age is that furnished by changes in range of the plants represented, and, as has been stated, these would be unlikely to be considerable in this situation (in respect to latitude, and situated in a relatively permanent river valley).

We have seen that these changes actually are slight, but that there have been some changes, and that certain species have withdrawn slightly to the southward, or more completely seaward in the present Coastal Plain, or both.

This points to a reasonable antiquity, as do the thickness of the deposit and the presence of large cypress butts at various levels. Adverse arguments based upon the freshness of preservation of the material are without the slightest force. I have seen fresher-looking wood from the Tertiary brown coal of Germany, where chemical tests reveal the presence of unaltered cellulose, and this is also said to be true for the inconceivably ancient Paleozoic coal in the province of Tula in Russia. I have collected equally modern-looking material from the Coastal Plain Upper Cretaceous. I see no reason for doubting the Pleistocene age of the deposit, which is indeed confirmed by other lines of evidence, and also by the exact similarity between the Walker deposits and others in tidewater Maryland and Virginia where the geological evidence is overwhelmingly positive.

At the same time I would deprecate the opinion of some students that this and similar deposits elsewhere along our Atlantic border are necessarily tens or hundreds of thousands of years old. I concede that such may be the case, but there is certainly no botanical evidence that the Walker plant bed is older than late Pleistocene.

GYMNOSPERMAE

TAXODIUM DISTICHUM (L.) L. C. Rich.(Pl. 1, f. 37–42; pl. 3).

It is probably impossible to differentiate *Taxodium distichum* from *Taxodium imbricarium* by means of the seeds and cone-scales. The stumps, which with the root systems and knees make up the bulk of the fossil swamp deposit, appear to be those of the former rather than the latter species.

The cone scales are not uncommon, but were apparently more perishable than the seeds, which are the most abundant objects present in the deposit. Both are characteristic. It is of interest that next in abundance are the galls of the midge, *Retinodiplosis taxodii*, or its immediate ancestor.

The bald cypress has a most interesting history and its immediate ancestor attained a Holarctic distribution during the Tertiary. The present species makes its appearance in geological record in the Pliocene of Alabama, and it was very common in southeastern North America during the Pleistocene, at which time it extended its range both northward and inland beyond its modern limits. It has been recorded from the Pleistocene in New Jersey, Delaware, Maryland, Virginia, North Carolina, Georgia, Florida, and Alabama.[1]

At the present time the bald cypress is confined to the Coastal Plain in this latitude, reaching its northern limits in southern Delaware and southern Maryland. It has not grown naturally in the District of Columbia in historic times. The Flora of the District (Washington, 1919) mentions it at Marshall Hall, Maryland, about 20 miles down the Potomac valley from the Walker Hotel site, but I have not observed it under unquestionable natural conditions nearer than southern Charles County, some miles distant.

That the Walker deposit was many years in formation is indicated by the section of a cypress log, between two and three feet in diameter, which is shown on Plate 3, figure 1. The lower third of this log, presumably buried in the more or less antiseptic swamp waters, was preserved, while the exposed two-thirds was subject to atmospheric conditions and hence decayed before the growth of the deposit was sufficient to entomb it. Cypress wood decays much more slowly than do most woods, and this possibly gives some measure of the rate of accumulation of the swamp deposit.

A section of one of the large pneumatophores or knees of the cypress, which are so common in the swamp deposit, is shown on Plate 3, figure 2.

ANGIOSPERMAE

MONOCOTYLEDONAE

Sparganium eurycarpum Engelm. (Pl. 1, f. 36)

This nut-like fruit, about which I entertained some doubt regarding its identity, has been positively determined for me by W. L. McAtee as identical with the recent fruits of this species.

The broad-fruited bur-reed, as it is called, is found in marshes and along streams from Newfoundland to Virginia and westward to British Columbia and California. It is the only identified form in the collection whose modern range is for the most part north of the Potomac River. It is frequent in swamps and along the marshy margins of streams in the District of Columbia at the present time.

[1] See Berry, E. W.: *Tree ancestors* 56–67. 1923.

The genus goes back to Eocene, and possibly to Upper Cretaceous times. It is common in European Pleistocene deposits, but there is only one other American record, that of its occurrence in the Pleistocene of North Carolina.[2]

NAIAS sp. (Pl. 1, f. 1–3)

Several specimens in the collection represent this genus. It has not been possible to positively determine them specifically, although among existing species they are most similar to those of *Naias marina* L. The pericarp is large, 2 to 4 mm. in length with a prominent, persistent style and a somewhat rugose surface. *Naias marina* is found in the existing flora of both North America and Europe in lakes and ponds. On the former continent it ranges from central New York to Florida, but it has not been recorded from the District of Columbia or Maryland. Three other forms of *Naias* are present in the District, but the fossil appears to be distinct from these. The genus goes back to the Eocene; there are three extinct species in the Pliocene of Holland, and four species have been found in interglacial deposits in Germany. No others are known from the American Pleistocene.

CAREX cf. COLLINSII Nutt. (Pl. 1, f. 4–8)

Achenes small, triangular-fusiform, widest medianly, and about equally narrowed to the base and to the long, flexuous persistent style. This form is exceedingly common in the collection. It appears to represent *Carex collinsii* Nutt., a species of swamps, ranging from Rhode Island to Georgia, and apparently rare in the present flora of the District, from which there is but a single record.

The genus is an old one and is supposed to date from the Upper Cretaceous. Many species have been recorded from the Pleistocene of Europe. The American Pleistocene records include Scarboro, Ontario;[3] Greens Creek, Ontario;[4] Tennessee[5] and Florida.[6]

CAREX cf. INTUMESCENS Rudge (Pl. 1, f. 9–11)

Achenes triangular-fusiform, stout, with an expanded base, narrowing upward into a long, stout, flexuous style. Not uncommon in the collection but much less abundant than the preceding. Carices are determined with extreme difficulty and there are so many species that it is extremely hazardous to attempt the identification of fossil material. Nevertheless the present fossils are extremely close to *Carex intumescens* Rudge, which occurs in swamps and wet woods from Newfoundland to Manitoba, and southward to Florida and Louisiana. In the present flora of the District this species is apparently confined to low wet woods of the Coastal Plain.

[2] Berry, E. W., Torreya **14**: 160. 1914.
[3] Coleman, A. P., Journ. Geol. **3**: 626. 1895.
[4] Penhallow, D. P., Geol. Soc. Am. Bull. **1**: 325. 1890.
[5] Berry, E. W., Torreya **22**: 11. 1922.
[6] Berry, E. W., Florida Geol. Surv. 9th Ann. Rept. 22. 1917.

SCIRPUS cf. LACUSTRIS L. (Pl. 1, f. 12)

Achene distinctly obovate in outline, plano-convex, mucronate. Bristles considerably longer than the achene. Several poor and one fairly satisfactory specimen were found, apparently representing *Scirpus lacustris* L., a species that is widely distributed in ponds and swamps throughout North America, and present also in Europe. It is not recorded in the Flora of the District.

Species of *Scirpus* are common in the European Pleistocene, but no others are known from North American deposits of this age except *Scirpus fluviatilis*, which is recorded by Coleman[7] from Scarboro, Ontario.

SCIRPUS cf. AMERICANUS Pers. (Pl. 1, f. 13–15)

The fossil achenes are smooth, biconvex, obovate in outline, and prominently beaked. The bristles are not preserved. They appear to represent *Scirpus americanus* Pers., which, in the existing flora, is found in both brackish and fresh water swamps. It is widely distributed throughout North America, and is reported from South America. In the Flora of the District it is reported as infrequent in open marshy situations on the flood plain of the Potomac River.

CLADIUM sp. (Pl. 1, f. 16)

A single achene in the swamp deposit is definitely referable to the genus *Cladium*, a genus with about 30 existing species, of which three are found in the United States—one eastern, one southern, and one on the Pacific coast. The fossil is much like the species of *Cladium* found in the early Pleistocene of Europe. It is close to the existing *Cladium mariscoides* (Muhl.) Torr., but may be distinct and represent an extinct species. The former is found in marshes from Nova Scotia to Florida but has not been recorded in the flora of the District. The genus is otherwise unknown in the Pleistocene of North America, although it is not uncommon in deposits of this age in Europe.

DULICHIUM ARUNDINACEUM (L.) Britton (Pl. 1, f. 17, 18)

The achenes of this species are among the commoner remains in the swamp deposit. This species, perhaps more commonly known as *Dulichium spathaceum* (L.) Pers., is a denizen of sluggish water bordering streams and ponds, and is found at the present time from Nova Scotia to Ontario and Minnesota, and southward to Florida and Texas. It is frequent in the District, especially along the Potomac River flats. In former times, that is, during the Pleistocene, this species had a much more extended range, undoubted specimens having been found in the Pleistocene of Holland, Denmark, and Germany.[8] The genus is monotypic in eastern North America at the present time, but four species have been described from the Pliocene of Holland.

[7] Coleman, A. P., Geol. Soc. Am. Bull. **26**: 247. 1915.

[8] Stoller, J., *Über das foss. Vorkommen der Gattung Dulichium in Europa.* Jahrb. k. Preuss. geol. Landes **30**: 161. 1909 (1911).

DICOTYLEDONAE

POLYGONUM HYDROPIPEROIDES Michx. (Pl. 1, f. 19–22)

Achenes not uncommon in the swamp deposit, about 0.104 inches in length. The illustrations fail to bring out their triangular cross-section. This species is found in swamps and wet places ranging from southern Canada to Florida and Mexico, and in California. In the Flora of the District of Columbia it is recorded, under the name of *Persicaria hydropiperoides* (Michx.) Small, from several stations along the Potomac, but is not common.

Fossil forms of *Polygonum* have been recorded from the Pleistocene of Ontario,[9] Maryland,[10] and Florida.[11]

POLYGONUM sp. (Pl. 1, f. 23)

This may possibly be a variant of the preceding species, or it may represent a second species of the genus. The fact that it is represented by the single specimen figured suggests that the first supposition is most likely the correct one.

CHENOPODIUM sp. (Pl. 1, f. 24)

This large seed of a *Chenopodium* is most like those of the existing *Chenopodium hybridum* L., a form of woods and thickets found from Canada to New Mexico and in the eastern United States from New Jersey northward to Quebec. It is therefore extra-limital in the District, but this loses its significance when it is recalled that almost any of our chenopodiums might produce a few big seeds like the fossil, although most of the species recorded in the Flora of the District are naturalized weeds.

PHYTOLACCA DECANDRA L. (Pl. 1, f. 26–28)

Characteristic seeds of this species are represented by several specimens in the collection. The pokeweed is found in various situations, usually in rich moist soil, from Maine and Ontario to Minnesota and southward to Florida and Texas. It has become naturalized in Europe. Its chief interest in the present connection is the fact that the balance of the genus is tropical and this species apparently represents a northward extension of range that took place at least as early as the late Pleistocene.

CASTALIA sp. (Pl. 1, f. 25)

These seeds, which have been identified for me by W. L. McAtee, are immature seeds of an undetermined species of water-lily. The only *Castalia* in the existing flora of the District is *Castalia odorata* (Dryand.) Woodv. & Wood, the common white water-lily, and the fossil may well represent that species. The genus has not been recorded hitherto in the North American Pleistocene.

[9] Coleman, A. P., Geol. Soc. Am. Bull. **26**: 247. 1915.

[10] Hollick, A., Maryland Geol. Surv. Plio-Pleistocene 231. 1906.

[11] Berry, E. W., Journ. Geol. **25**: 662. 1917.

Ceratophyllum demersum L. (Pl. 1, f. 33–35)

The hornwort fruit, which is a nut or achene, shows considerable variation in its spinelike beak (the persistent style), and in the degree to which the margin is spined or tuberculated. Several supposed species have been based upon these variations of the fruit, the fossil resembling the variety *echinatum* A. Gray. Many botanists, however, believe these differentiations to be valueless.

The plant is a submerged aquatic of ponds and slow streams, and at the present time it is found throughout all of North America except the far north. The fossil fruits are characteristic, and I have figured one 4/5's natural size, showing the beak, and two others enlarged, in which the beaks are broken away. The species is found in the District at the present time near the Potomac River from Plummers Island southward, but rarely fruiting, being generally propogated by buds. The genus is not otherwise known in the American Pleistocene.

Ranunculus sp. (Pl. 1, f. 29–31)

There are numerous specimens and some variety of achenes that can be rather confidently referred to this genus. They doubtless represent more than a single species, but I do not feel that they can be conclusively identified. The present flora of the District includes 12 species of *Ranunculus*. Several species have been recorded from Pleistocene deposits in Europe, where they seem to be determined with a great deal of confidence; but none are known from the American Pleistocene, although *Ranunculus aquatilis* L., has been found in what is called post-Pleistocene, at Hadley, Massachusetts.[12]

Rubus sp. (Pl. 2, f. 1)

These characteristic seeds of some species of *Rubus* are exceedingly common in the swamp deposit. After an extended comparison with the seeds of recent species of raspberries and blackberries I have concluded that specific identification based on the seeds alone is unreliable, although several European students of fossil seeds have apparently not found this to be the case.

There are six species of *Rubus* in the existing flora of the District, and the fossil probably represents the modern *Rubus hispidus* L. which occurs in low woods, especially in the Coastal Plain. A rubus stone has been recorded from the Pleistocene of Alabama.[13] and a prickly twig from deposits of this age in North Carolina.[14]

Prunus serotina Ehrh.? (Pl. 2, f. 2, 3)

These stones, of which several specimens have been found, are small, smooth, and nearly globose. They very probably represent a Pleistocene ancestral form of the black cherry, *Prunus serotina* Ehrh., although this identification

[12] Emerson, B. K., U. S. Geol. Surv. Bull. **597**: 148. 1917.

[13] Berry, E. W., Torreya **14**: 161. 1914.

[14] Berry, E. W., Journ. Geol. **15**: 344. 1907.

is not positive. This species, in the existing flora, is a denizen of rich woods and open places from southern Ontario to Florida, and westward to the eastern praïrie states. It is frequent to the existing flora of the District. The presence of these stones in the swamp deposit might be explained as having been due to water transport after drying, but their presence is much more readily explained as having been due to the droppings of birds, which normally distribute them very widely.

The genus *Prunus* is supposed to date from the Upper Cretaceous, and stones have been found in the lower Eocene of the United States.[15] Several species have been recorded from the Pleistocene of Europe, and in this country Pleistocene species are known from Ontario,[16] from cave deposits in Pennsylvania,[17] and from post-glacial beds in Massachusetts.[18]

ACALYPHA VIRGINICA L. (Pl. 2, f. 10)

This large, mostly tropical and sub-tropical genus of herbs and shrubs extends northward as far as Ontario in the case of this single herbaceous species. Characteristic seeds are present in the swamp deposit. In the modern flora this species is an inhabitant of woods and thickets ranging from Ontario to Florida, and it is common in the existing flora of the District. The genus is not known elsewhere in the fossil state.

ILEX OPACA Ait. (Pl. 2, f. 4, 5)

The seeds of this species are not uncommon in the swamp deposit. In the existing flora it is found in low moist woods from southern New England to eastern Texas, and, except in the south Atlantic states, it is almost entirely confined to the Coastal Plain. Five species of *Ilex* have been recorded from the Pleistocene of North America, the present species occurring in beds of that age in North Carolina[19] and Alabama.[20]

VITIS CORDIFOLIA Michx. (Pl. 2, f. 6–9)

Seeds of the chicken or frost grape are among the most abundant fossils in the swamp deposit, ranking next to the seeds of the bald cypress in abundance. They are frequently broken and are invariably hollow, as are most of the associated remains. They show considerable variation in size and form but are believed to represent a single species. The extremes of size are figured.

This species, which is also known as the possum and winter grape, is an inhabitant of low moist thickets and stream banks, and is found from New

[15] Berry, E. W., U. S. Geol. Surv. Prof. Paper **91**: 221, *pl. 116, f. 1.* 1916.

[16] Penhallow, D. P., Am. Nat. **41**: 448. 1907; Coleman, A. P., Geol. Soc. Am. Bull. **26**: 247. 1915.

[17] Mercer, H. C., Journ. Acad. Nat. Sci. Phila. ser. 2, **11**: 281. 1899.

[18] Emerson, B. K., U. S. Geol. Surv. Bull. **597**: 148. 1917.

[19] Berry, E. W., Journ. Geol. **15**: 345. 1907.

[20] Berry, E. W., Am. Nat. **41**: 686, *pl. 2, f. 1.* 1907.

England westward to Nebraska, and southward to Florida and Texas. It is recorded as not uncommon in the flora of the District.

Grape seeds of various species, usually unidentified specifically, are common in the Pleistocene of the Atlantic Coastal Plain, and have been recorded from New Jersey,[21] Maryland,[22] Virginia,[23] and North Carolina.[24]

AMPELOPSIS (?) sp. (Pl. 2, f. 19)

A small berry-like, pedicellate fruit, apparently two-seeded, is tentatively referred to the genus *Ampelopsis*, and may be compared with the fruits of existing *Ampelopsis cordata* Michx., a species of swamps and river banks, found at the present time from southern Virginia to Florida, and westward to Illinois, Kansas, and Texas. The fossil is too small to represent a normal fruit of *Ampelopsis arborea* (L.) Rusby, which is a native of the District at the present time. Its identification is too uncertain to be considered as of special significance.

CORNUS AMOMUM Mill. (Pl. 2, f. 15–18)

The silky cornel, swamp dogwood, or kinnikinnik, is a shrub of low woods and stream banks, which, at the present time, ranges from New Brunswick and Ontario westward to Dakota and Nebraska, and southward to Florida and Texas. It is not at all uncommon in the modern flora of the District.

The stones of this species are not uncommon in the swamp deposit. They are usually somewhat compressed, pointed at both ends, unsymmetrical in outline, and irregularly ridged. Specimens are figured showing lateral and vertical views, as well as in section showing the two cells.

Stones belong to different species of the genus *Cornus* are not uncommon in the Pleistocene of Europe. In deposits of this age in North America the only previous record is in the Pleistocene of New Jersey.[25]

LEUCOTHOË RACEMOSA (L.) A. Gray (Pl. 2, f. 11–14)

This species, which is new to the Pleistocene of North America, is represented in the swamp deposit by the single depressed-globose, 5-valved capsule figured, and by numerous detached loculicidal valves, some of which are figured from different angles.

The swamp leucothoë is usually found in swamps and moist thickets, although it may also occur in drier situations. It is found from Massachusetts to Florida and Louisiana at the present time, and is usually restricted to localities in the Coastal Plain. It is recorded, under the name of *Eubotrys racemosa* (L.) Nutt., as frequent, in the flora of the District of Columbia.

[21] Berry, E. W., Torreya **10**: 266. 1910.
[22] Hollick, A., Maryland Geol. Surv. Pleistocene 235. 1906.
[23] Berry, E. W., Torreya **6**: 89. 1906.
[24] Berry, E. W., Journ. Geol. **15**: 345. 1907.
[25] Penhallow, D. P., Trans. Roy. Soc. Canada, ser. 2, sec. **4**: 70. 1896.

GALIUM sp. (Pl. 2, f. 20)

With the exception that the two specimens collected have an aperture at both poles, they are very similar to the fruits of various species of *Galium*. Since the embryo in Galium seeds is at the pole this region would probably be one to decay more rapidly, which might account for the double opening. Specific identification is impossible, but the specimens suggest the Holarctic recent species *Galium triflorum* Michx., which, in the existing flora of North America, is a woodland species, ranging from Nova Scotia to Alaska, and southward to California, Louisiana, and Alabama. It is common in damp woods in the existing flora of the District of Columbia, in which seven other species of *Galium* are also reported. *Galium* has been recorded from the European Pleistocene, but has not been found heretofore in deposits of that age in America.

SAMBUCUS CANADENSIS L. (Pl. 2, f. 21–24)

The one-seeded, rough-surfaced nutlets of this species are rather common in the swamp deposit. The elder, or as it is more commonly termed, the elder-berry, inhabits wet situations generally thickets, and at the present time ranges from Nova Scotia westward to Manitoba and Kansas, and southward to Florida and Texas. It is still abundant in the District of Columbia. The genus has not been known before in the American Pleistocene.

VIBURNUM NUDUM L. ? (Pl. 2, f. 25)

The specimen is a stone apparently belonging to this species, which, in the existing flora, is a rather large shrub of swamps, ranging from Long Island to Florida, and westward to Kentucky and Louisiana. It is common in swampy and wet places in the present flora of the District. This species has been reported from the Pleistocene of North Carolina[26] and Florida.[27]

VIRURNUM sp. (Pl. 2, f. 30)

This flattened equilateral stone is typical of certain species of *Viburnum* and probably represents the modern species *Viburnum prunifolium* L., which, in the existing flora, is a shrub or small tree, ranging from Connecticut to Florida. If this is the correct affinity of the fossil it may be an example of a dry-soil element otherwise unrepresented in this deposit, although the black haw is not especially restricted in its habitat and is found in a variety of situations. It is common in the existing flora of the District. In the absence of certainty of identification it would be futile to discuss the meaning of its presence in the present assemblage. It has not before been found fossil, although the stones of several other species of *Viburnum* have been found in the Pleistocene of the United States.

[26] Berry, E. W., Torreya **14:** 160. 1914.
[27] Berry, E. W., Journ. Geol. **25:** 662. 1917.

Additional plant remains which are shown on the accompanying plates, and which are not positively determined, comprise the following:

1. A characteristic prickle, evidently of some species of *Rubus* or *Rosa* (Pl. 2, f. 27).
2. Fruits that appear to represent some undetermined species of the family Ranunculaceae (Pl. 2, f. 26).
3. Immature fruits of the genus *Ranunculus* (Pl. 1, f. 32; pl. 2, f. 28).
4. Immature fruits of sedges, probably representing the genera *Carex* and *Scirpus* (Pl. 2, f. 31).

HEXAPODA-DIPTERA

RETINODIPLOSIS sp. (Pl. 2, f. 32–34)

These galls are very abundant in the swamp deposit. They are roughly spherical, thick walled, monothalamous, about 5 mm. in diameter. Dr. E. P. Felt, the well known authority on galls, has kindly examined them and states that they belong to the genus *Retinodiplosis* Kieff, of the family Itonididae—the gall midges.

Although possibly specifically distinct they are very close to the species *Retinodiplosis taxodii* Felt,[28] whose galls are tightly packed in the cones of the cypress and probably represent modified or aborted seeds. Dr. Felt considers this cypress midge as decidedly more primitive than the other species of the genus occurring in the pines.

ITONIDA sp. (Pl. 2, f. 29)

These galls are small, rotately 5-lobed and stalked. Several specimens have been found in the swamp deposit, but they are much less abundant than the *Retinodiplosis* galls. They were examined for me by W. L. McAtee who, however, is not responsible for the generic name. The genus *Itonida* belongs to the same family as *Retinodiplosis*, and is a more modern name for the well known term *Cecidomyia*.

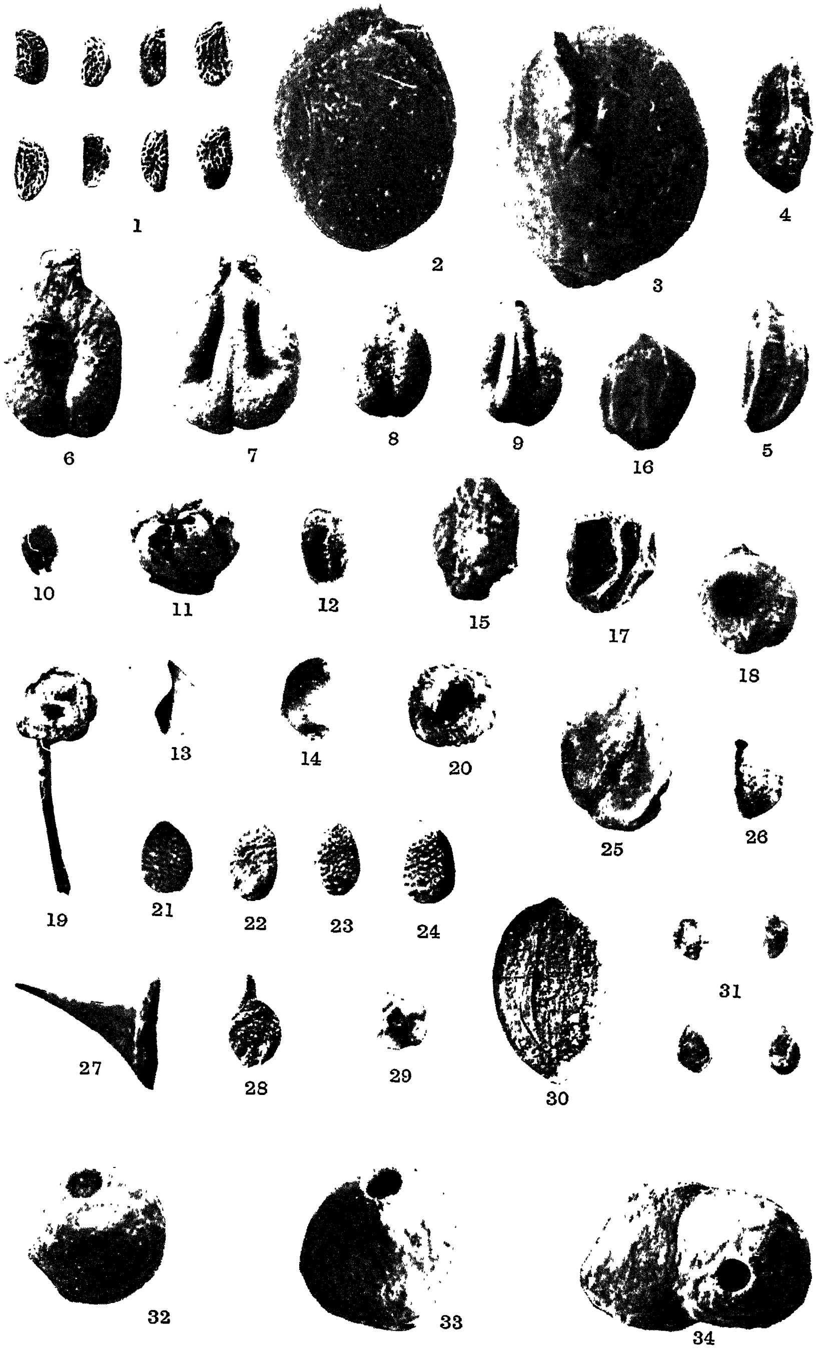
The fossil galls are very close to the galls of *Itonida anthici* Felt,[29] and very probably represent that species. The latter are flower-like, and are borne on the leaves of the bald cypress. For their general appearance in life the reader is referred to an illustration published by Dr. Felt.[30]

[28] Felt, E. P., Ent. News 27: 415–417. 1916.

[29] Felt, E. P., Econ. Ent. Journ. 6: 278. 1913.

[30] N. Y. State Mus. Bull. pp. 231–232. 1920.

BERRY ON ORGANIC REMAINS



BERRY ON ORGANIC REMAINS

BERRY ON ORGANIC REMAINS

Plate 1

Figs. 1–3. *Naias* sp.
Figs. 4–8. *Carex* cf. *collinsii* Nutt.
Figs. 9–11. *Carex* cf. *intumescens* Rudge.
Fig. 12. *Scirpus* cf. *lacustris* L.
Figs. 13–15. *Scirpus* cf. *americanus* Pers.
Fig. 16. *Cladium* sp.
Figs. 17, 18. *Dulichium arundinaceum* (L.) Britton.
Figs. 19–22. *Polygonum hydropiperoides* Michx.
Fig. 23. *Polygonum* sp.
Fig. 24. *Chenopodium* sp.
Fig. 25. *Castalia* sp., immature.
Figs. 26–28. *Phytolacca decandra* L.
Figs. 29–31. *Ranunculus* sp.
Fig. 32. *Ranunculus* sp., immature.
Figs. 33–35. *Ceratophyllum demersum* L.
Fig. 36. *Sparganium eurycarpum* Engelm.
Figs. 37–42. *Taxodium distichum* (L.) Rich., cone scales and seeds.

All of the figures on this plate are from untouched photographs and all are uniformly enlarged four times natural size except Figure 33 which is $\frac{4}{5}$ natural size.

Plate 2

Fig. 1. *Rubus* sp., eight stones.
Figs. 2, 3. *Prunus serotina* Ehrh. (?), 2 stones.
Figs. 4, 5. *Ilex opaca* Ait.
Figs. 6–9. *Vitis cordifolia* Michx. showing maximum and minimum sozed seeds.
Fig. 10. *Acalypha virginica* L.
Figs. 11–14. *Leucothoe racemosa* (L.) A. Gray. Fig. 11 shows a complete capsule, and Figs. 12–14 show detached valves, the usual method of occurrence.
Figs. 15–18. *Cornus amomum* Mill., various stones. Fig. 17 shows one in cross-section.
Fig. 19. *Ampelopsis* (?) sp.
Fig. 20. *Galium* sp.
Figs. 21–24. *Sambucus canadensis* L.
Fig. 25. *Viburnum nudum* L. (?)
Fig. 26. Fruit of some member of the Ranunculaceae.
Fig. 27. Thorn of *Rubus* or *Rosa*.
Fig. 28. *Ranunculus* sp., immature.
Fig. 29. *Itonida* sp., Gall of cypress leaf midge viewed from above.
Fig. 30. *Viburnum* sp., probably prunifolium L.
Fig. 31. Fruits of sedges, immature.
Figs. 32–34. *Retinodiplosis* sp., cypress cone galls.

All of the figures on this plate are from untouched photographs and all are uniformly enlarged four times natural size.

Plate 3

Fig. 1. Cross-section of cypress log.
Fig. 2. Longitudinal section of cypress knee.

DIATOM DEPOSIT FOUND IN THE EXCAVATION

Albert Mann, National Museum

In making the excavations under discussion it was found necessary to dig down to bed-rock, as building operations in the vicinity had shown the locality to be swampy and a stream to have had its bed nearby. The site had been filled in by the city. To reach a solid foundation digging was carried to a depth of 35 to 40 feet below the level of the adjacent streets. Close to the bottom of the excavation a swamp-like deposit was uncovered, in which were embedded the stumps of large bald cypress trees (*Taxodium distichum*) in a fair state of preservation. The soil in which they had flourished was dark gray, almost black, and of a decidedly peaty texture, and was found to be richly mixed with the silica remains of fresh water diatoms. The material having been cleaned, the diatom flora proves so unique that a report seems to be called for.

In all, 78 species and notable varieties of diatoms have been detected in this deposit, which is rather more than the number of species usually found in fresh water localities in and about Washington at the present time. A large proportion of these are now locally unrepresented. In fact, so many are very rare and unique that one may be led to infer either that their life-period dates back very many years and that the deposit is a sub-fossil one, or that they flourished under quite different conditions from those of the present time. Their antiquity is further suggested by the fact that many of the specimens are in a decayed or "rotten" condition, indicating that they have been subjected for a long time to some corrosive agency. This is especially noticeable in those species that have thin and delicate "frustules," the technical name given to the silica boxes or encasements that surround the life-substance of diatoms. Since silica, the material composing these diatom boxes, is affected only by hydrofluoric acid and by alkaline solutions, the corrosion here noted must have required a great many years. A weak solution of potash, soda, or lime, such as is generally found in alkaline soils, has only a very feeble and slow effect as a silica solvent. It may be added that there are rather an unusual number of distorted and misshapen diatoms present, and that this distortion is rather common where these microscopic plants are forced to grow in alkaline waters, especially if lime is present.

Another fact suggestive of the age of this deposit is that a number of uncommon species found here are characteristic of certain fossil diatom beds located in central Alabama, notably at Montgomery. In the Alabama State Geological Survey for 1894 is a report by K. N. Cunningham on the fossil diatoms of Montgomery, the geological age of which has been fixed as Pleistocene. Material from this precise spot is now not procurable, because the city has extended over the most of the diatom bed. But samples obtained from outcrops locted in the suburbs of the city have been examined and these agree in general with the Cunningham report. He lists 55 species, of which 44, or 80 per cent, have been found in the Connecticut avenue deposit. Of the 11 not found there nearly all are very minute forms, which may have escaped discovery in the examination of the local material. It should be noted that the close resemblance between these two deposits is seen not so much in the number of species common to both as in the rarity of many of the species common to both; and it must be recognized as a significant fact that the diatoms of the two beds—one Pleistocene fossil at Montgomery, Alabama, and the other here at Washington—are strikingly like each other and quite unlike the usual diatoms now found in a living state in the two localities.

To confirm this last point I have examined the diatom flora of a bald cypress swamp near Cape Henry, Virginia. A few of the species found therein are present in the Connecticut avenue material; but they represent only such cosmopolitan species as inevitably are looked for in any fresh-water growths, fossil or recent, occurring in this part of the world. This correspondence therefore has little significance, especially as these recent cypress-swamp diatoms do not include a single one of the rare and unusual species found in the local material, in the Pleistocene material from Montgomery, and in some supposedly fossil material from Crane Pond, Massachusetts, the peculiarities of which will be hereafter noted. In other words, the diatoms of the local swamp are strikingly like those of the two fossil deposits and strikingly unlike those of the near-by bald cypress swamp now growing under practically identical conditions.

The remarkable similarity between a diatom flora found at Crane Pond, Massachusetts and this local flora is worthy of further attention. At the time that material was distributed to diatom students, it was understood to have been obtained from a stratum 13 feet below the mud surface of the bottom of the pond, although I am unable to find any reference in diatom literature to confirm this. At any rate, no

considerable number of the Crane Pond species have been met with elsewhere until they appear in this Connecticut avenue excavation In other words, most of the species common to Crane Pond and to the Connecticut avenue deposit are rare, and even when discovered at other localities are always commented upon as unusual. Thus, a few are recorded from French's Pond, Albany, Maine; from Wolfboro, on Lake Winnepesaukee, New Hampshire; from Waltham, Massachusetts; and, strangest of all, from the Demerara River in British Guiana. But the parallel existing between any of these is far less striking than that between Crane Pond and this local deposit.

Of the 78 species and well-marked varieties found in the local deposit 64, or over 80 per cent, belong also to the Crane Pond diatom flora. In the appended list the species common to both localities are marked with an asterisk. The parallel here shown is so close that it is fair to assume that the two floras would be found to be even more, rather than less, alike if an exhaustive study supplied us with complete lists from both places.

One of the rare species frequent in the Connecticut avenue material brings out an interesting fact. It is called *Navicula Schinzii* Br. It was first discovered in two fresh water lakes in West Africa, Olukonda and Ombika, and was subsequently discovered in the fossil material at Montgomery, Alabama. To rediscover this very rare diatom so far away from its first place of discovery is interesting, and to find that it seems to have developed nowhere in this country except in the Pleistocene deposit at Montgomery and in this bald cypress swamp in Washington is even more so. It certainly strengthens the belief that this local swamp dates back in its origin a great many years.

It may be well to summarize the three points of special interest in this study: (1) There is a great dissimilarity between the present-day local diatom flora, including that of near-by bald cypress swamps, and the diatom flora of the Connecticut avenue deposit; (2) there is a striking similarity between the diatoms of the local deposit and those found in the supposedly fossil material from Crane Pond, Massachusetts, and in the fossil bed at Montgomery, Alabama (3) there is an indication of the antiquity of this deposit shown by the decayed condition of many of the specimens, suggestive of long subjection to the corrosive effect of alkaline waters. The writer's knowledge of Geology is too superficial to warrant any conclusion as to the precise age of this deposit, based on a study of its diatoms. But it can

be safely stated that in view of this study the burden of proof must rest on anyone who claims that this swamp is one of recent origin.

LIST OF SPECIES[1]

AMPHORA PROTEUS Greg.* Sch. At. *pl. 27, f. 4, 7.*
COCCONEIS PLACENTULA E.* Sch. At. *pl. 192, f. 45.*
COCCONEIS PLACENTULA var.*
CYMATOPLEURA ELLIPTICA (Breb.) W. S. V. H. Syn. *pl. 53, f. 1–4.*
CYMBELLA AMERICANA A. S.* Sch. At. *pl. 9, f. 15, 20.*
CYMBELLA AMERICANA var. ACUTA* Sch. At. *pl. 71, f. 75–78.*

This is one of the forms which is also reported from the Demerara River, British Guiana. No other locality is given, but it occurs here and in Crane Pond.

CYMBELLA EHRENBERGII K.* V. H. Syn. *pl. 2, f. 1.*
CYMBELLA GASTROIDES K.* V. H. Syn. *pl. 2, f. 8.*
CYMBELLA LANCEOLATA E.* V. H. Syn. *pl. 2, f. 7.*
CYMBELLA LUNULA (E.) Rab.* Sch. At. *pl. 71, f. 33;* V. H. Syn. *pl. 3, f. 16A.*
EPITHEMIA ARGUS (E.) K. V. H. Syn. *pl. 31, f. 151.*
EPITHEMIA ARGUS var. AMPHICEPHALA Grun.* V. H. Syn. *pl. 31, f. 19.*
EPITHEMIA GIBBA (E.) K.* V. H. Syn. *pl. 32, f. 5.*
EPITHEMIA GIBBA var. VENTRICOSA Grun.* V. H. Syn. *pl. 32, f. 4, 5.*
EPITHEMIA TURGIDA (E.) K.* V. H. Syn. *pl. 31, f. 1, 2.*
EUNOTIA FORMICA E. V. H. Syn. *pl. 34, f. 1.*
EUNOTIA GRACILIS (E.) Rab.* V. H. Syn. *pl. 33, f. 1, 2.*
EUNOTIA MINOR (K.) Rab.* V. H. Syn. *pl. 33, f. 20, 21.*
EUNOTIA MONODON E.* V. H. Syn. *pl. 33, f. 3.*
EUNOTIA PECTINALIS (K.) Rab.* type. V. H. Syn. *pl. 33, f. 16.*
EUNOTIA PECTINALIS var. UNDULATA Ralfs.* V. H. Syn. *pl. 33, f. 17.*

Not only the type form of this species is found here but a curious variety called var. *undulata*. It was named "Himantidium undulatum" in S. B. D. 2: 12, *pl. 33, f. 281a,*[2] and an excellent figure of the precise form common to both the Crane Pond and the Connecticut avenue

[1] The references included are to satisfactory illustrations in diatom literature. The abbreviations used are as follows:

Authors: Ag. = Agardh; A. S. = Adolph Schmidt; Br. = Brun; Cl. = Cleve; E. = Ehrenberg; Greg. = Gregory; Grun. = Grunow; Hantz. = Hantzsch; H. Heid. = H. Heiden; K. = Kutzing; Rab. = Rabenhorst; W. S. = William Smith; V. H. = Van Heurck.

Books: Cl. Nav. Diat. = CLEVE: *Naviculoid diatoms.*
Cl. & Grun. Arct. Diat. = CLEVE & GRUNOW: *Arctic diatoms.*
Espec. Nouv. = BRUN: *Especes nouvelles.*
H. L. S. Types = H. L. SMITH: *Diatomacearum species typicae.*
Mic. Jour. = Monthly Microscopical Journal, London.
Per. Mono. = H. PERAGALLO: *Monographie du genre Pleurosigma.*
S. B. D. = WILLIAM SMITH: *British diatoms.*
Sch. At. = *Schmidt's Atlas der Diatomaceen*-Kunde.
V. H. Syn. = VAN HEURCK: *Synopsis des diatomees de Belgique.*
W. & C. N. & R. Diat. = WALKER & CHASE: *New and rare diatoms.*

deposits is given in Lewis, White Mt. Diat. *pl. 2, f. 13a.* The similarity between these two diatom floras is especially emphasized by this form, because the peculiarities of modification are therein duplicated to the minutest detail.

EUNOTIA ROBUSTA (E.) Ralfs.* V. H. Syn. *pl. 33, f. 12.*

GOMPHONEMA ACUMINATUM E.* V. H. Syn. *pl. 23, f. 15, 16.*

GOMPHONEMA GRACILE E.* Sch. At. *pl. 236, f. 16.*

GOMPHONEMA GRACILE var. LANCEOLATA E. Sch. At. *pl. 236, f. 26.*

GOMPHONEMA SUBTILE E. Sch. At. *pl. 236, f. 10;* V. H. Syn. *pl. 23, f. 13.*

MELOSIRA DISTANS (E.) K.* V. H. Syn. *pl. 86, f. 21, 28.*

MELOSIRA LAEVIS (E.) Grun. V. H. Syn. *pl. 88, f. 191,* misnamed in Sch. At. *pl. 182, f. 36 M. Roeseana* Rab.

NAVICULA ACROSPHAERIA var. LAEVIS Breb. Sch. At. *pl. 43, f. 18.*

NAVICULA AFFINIS E. var.* Sch. At. *pl. 49, f. 1.*

NAVICULA AMERICANA E.* V. H. Syn. *pl. 12, f. 37.*

NAVICULA AMERICANA narrow var. Sch. At. *pl. 312, f. 14.*

NAVICULA AMPHIRHYNCHUS E.* Sch. At. *pl. 49, f. 27–29.*

NAVICULA APPENDICULATA (Ag.) K.* V. H. Syn. *pl. 6, f. 18, 19.*

NAVICULA BACILLUM E.* V. H. Syn. *pl. 13, f. 8;* Cl. & Grun. Arct. *pl. 2, f. 50.*

Navicula bihastata Mann, nom. nov.* Pl. 4, f. 2; see also Cl. Nav. Diat. **2**:88, *pl. 1, f. 21.*

This has been called *Pinnularia trigonocephala* by Cleve (Nav. Diat. **2**:88, *pl. 1, f. 21*), where there is a good illustration. The restoration of the indistinct genus *Pinnularia* not being advisable, and *Navicula trigonocephala* being preempted by Ralfs, I find it necessary to assign to it a new name. This is quite a rare species.

NAVICULA CARDINALICULUS (Cl.) Mann, Cl. Nav. Diat. **2**:79, *pl. 1, f. 12a.*

Cleve says that this is found in Crane Pond, Massachusetts; French's Pond, Albany, Maine; and Houghton, Michigan.

Navicula cuneicephala Mann, nom. nov.* Pl. 4, f. 5; see also Sch. At. *pl. 43, f. 19.*

My form agrees closely with the illustration in Schmidt's Atlas; but, as in the case of *N. bihastata,* I cannot use the specific name already given because of *N. integra* W. S.

NAVICULA CUSPIDATA K.* V. H. Syn. *pl. 12, f. 4.*

All the specimens of this species found at Crane Pond and in the local deposit are peculiar in being narrowed at either end into an elongated tip. The type form, which is common throughout this part of the world at the present time, is much more truly spindle-shaped.

NAVICULA DACTYLUS (E.) K.* V. H. Syn. *pl. 5, f. 1;* Sch. At. *pl. 42, f. 6.*

NAVICULA ELLIPTICA K.* H. L. Sm. Types *pl. 271.*

NAVICULA EXIGUA Greg.* V. H. Syn. *pl. 8, f. 32;* Mic. Journ. **1854**: *pl. 4, f. 14.*

It is possible this species is a variety of *N. Gastrum.*

NAVICULA FLEXUOSA Cl.* Nav. Diat. **2**:93, *pl. 1, f. 23.*

This species was found originally in Crane Pond, and forms found here and in that material are identical. It is possible that this species is invalid and should be looked upon as a variety of *N. Dactylus.*

NAVICULA GIBBA (E.) var.* Sch. At. *pl. 45, f. 48.*

NAVICULA INSTABILIS A. S.* Sch. At. *pl. 43, f. 36.*

NAVICULA INSTABILIS A. S. var.* Sch. At. *pl. 43, f. 37.*
There are two well-marked forms of this species, corresponding to the figures given.
NAVICULA IRIDIS E. var.* Sch At. *pl. 49, f. 2, 4.*
NAVICULA LEGUMEN (E.) A. S.* Sch. At. *pl. 44, f. 44–47.*
NAVICULA LIMOSA K.* V. H. Syn. *pl. 12, f. 18–21.*
Perhaps a variety of *N. gibberula* K.
NAVICULA MAJOR K. Typical.* Sch. At. *pl. 42, f. 8.*
NAVICULA MESOLEPTA var. STAURONEIFORMIS (E.) Grun.* Sch. At. *pl. 45, f. 52, 53.*
NAVICULA NOBILIS (E.) K.* Sch. At. *pl. 43, f. 1.*
NAVICULA PERIPUNCTATA Br.* Expec. Nouv. p. 37, *pl. 16, f. 11;* also Sch. At. *pl. 311, f. 5–7,* misnamed.
Schmidt, in the reference above given, confuses this with the very different *N. Formica* E. So far as I know, this delicate species has never been found, except at Crane Pond, until discovered here.
NAVICULA PRODUCTA W. S.* S. B. D. *pl. 17, f. 144;* Sch. At. *pl. 49, f. 38.*
NAVICULA PRODUCTA var.* Sch. At. *pl. 49, f. 40,* unnamed.
NAVICULA RUPESTRIS (Hantz) A. S.* Sch. At. *pl. 45, f. 43.*
Perhaps this is a variety of *N. commutata* Grun., as figured in Sch. At. *pl. 45, f. 37.*
NAVICULA SCHINZII Br. Pl. 4, f. 4; see also Sch. At. *pl. 242, f. 9.*
The presence of this diatom in this gathering, found originally in west Africa and subsequently in a fossil bed in Alabama, has been already discussed.
NAVICULA SILLIMANORUM (E.) K.* Lewis, White Mt. Diat. *pl. 2, f. 8;* W. & C. N. & R. Diat. *pl. 2, f. 2.*
NAVICULA SUBACUTA A. S.* Sch. At. *pl. 42, f. 8,* passing into the next.
NAVICULA VIRIDIS (Nitz.) K.
NAVICULA SUBCAPITATA (Greg.) V. H. Sch. At. *pl. 44, f. 53, 55;* V. H. Syn. *pl. 6, f. 22.*
NAVICULA SUBOVALIS (Cl.) Mann.* Nav. Diat. **1**:96, *pl. 1, f. 27.* Pl. 4, f. 4.
This diatom, called by Cleve *Diploneis subovalis,* was found in fresh water material from New Zealand. It closely resembles *N. elliptica* K. in shape and size, but has the markings of *N. Smithii* Breb. I have found rare specimens of it in several fresh water gatherings; and as *N. Smithii* is a marine form, I have hitherto considered it as an adaptation of that species to fresh water conditions. It is interesting to note that it is a common form in Crane Pond.
NAVICULA TABELLARIA (E.) K.* V. H. Syn. *pl. 6, f. 8.*
Navicula torta Mann, nom. nov.* Pl. 4, f. 6.
This diatom is well illustrated by Cleve (Nav. Diat. **2**: *pl. 1, f. 22*) but misnamed as a variety of *N. major* K. (*N. major* var. *asymmetrica*). It has nothing to do with *N. major* but more nearly resembles *N. Trevelyana* Donk., but it should be recognized as an independent species. It is quite constant, although found in such widely distributed localities as Canada, Waltham and Crane Pond, Massachusetts, and fossil deposits at Montgomery, Alabama.
NAVICULA TRANSVERSA A. S.* Sch. At. *pl. 43, f. 56.*
NAVICULA TRINODIS W. S. Lewis, Diat. U. S. Seaboard *pl. 2, f. 6.*
The local examples of this very small and oddly shaped diatom have more rounded ends than illustrations generally give, but there is no question of its belonging to this species.

NAVICULA VIRIDIS K.* Sch. At. *pl. 42, f. 3.*
NITZSCHIA HEUFLERIANA Grun. V. H. Syn. *pl. 68, f. 13, 14.*
NITZSCHIA SPECTABILIS (E.) Ralfs.* V. H. Syn. *pl. 67, f. 8(?).*
NITZSCHIA TRYBLIONELLA Hantz var. LEVIDENSIS (W. S.) Grun. V. H. Syn. *pl. 57, f. 17.*
PLEUROSIGMA SPENCERII W. S. Per. Mono. *pl. 8, f. 20, 21.*
STAURONEIS ACUTA W. S.* V. H. Syn. *pl. 4, f. 3.*

This and the other species here classified under this generic name are unquestionably members of the genus *Navicula*. The utterly untrustworthy distinguishing mark, the stauros, appears so frequently in species that can not be classed in the same genus that any hope of a definite description is impossible. The subject is discussed at length in my *Report on the diatoms of the Albatross voyages*. I use the above generic name here because it has strongly entrenched itself in literature and will aid in understanding the references given.

STAURONEIS ALABAMAE H. Heid.* Sch. At. *pl. 242, f. 4,* var.
STAURONEIS ANCEPS E.* Sch. At. *pl. 242, f. 7,* passing into the next.
STAURONEIS PHOENICENTERON E.* V. H. Syn. *pl. 4, f. 2.*
Stauroneis Washingtonia Mann, sp. nov. Pl. 4, f. 3 and 7.

Valve narrow-lanceolate, with nearly straight sides, tapering from the center to the rounded apices; stauros narrow but not linear, not spreading, reaching to the sides; longitudinal median area evident on each side of the strong raphe, the ends of which are well separated at the center; markings, rows of beaded lines, all strongly oblique, and unusually coarse for the size of the diatom.

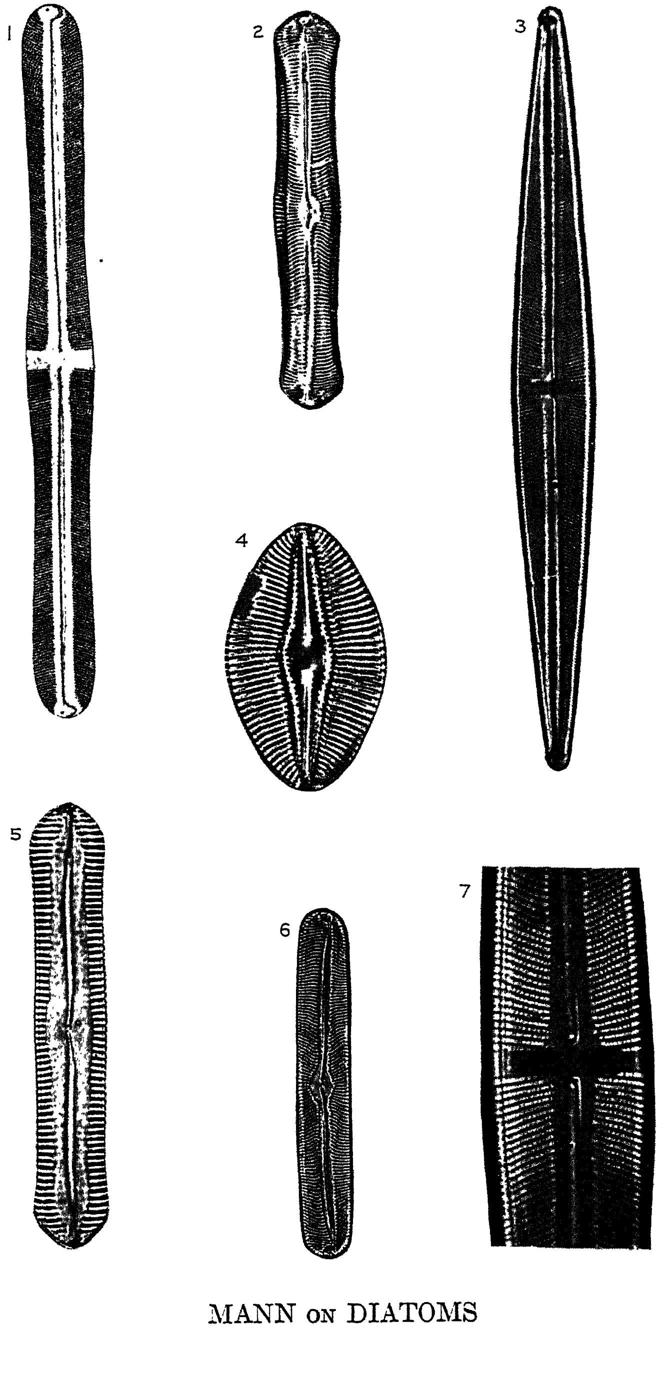
Length, 0.163 to 0.194; width, 0.020 to 0.022; 11 to 12 lines in 0.01 mm.

This does not seem to occur in the Crane Pond material, nor is there any figure closely resembling it in diatom literature. A species somewhat similar in shape is *S. Spicula* Dickie, a good figure of which is in V. H. Syn. *pl, 4, f. 9.* But that is a marine form, with very fine rectilinear markings, 28 to 29 in 0.01 mm., and with a delicate linear stauros. The lines of the present species are very coarse, even coarser than those of the much larger *S. Phoenicenteron*, which has 14 or more in 0.01 mm. It is common in the local deposit.

SURIRELLA ENGLERI O. Moller,* Sch. At. *pl. 245, f. 13–18.*
SURIRELLA TENERA Greg.* Sch. At. *pl. 23, f. 4–9.*
SURIRELLA TENERA wide var.* Sch. At. *pl. 23, f. 17.*

PLATE 4

Fig. 1, *Navicula Schinzii* Br.; 2, *Navicula bihastata* Mann, nom. nov.; 3, *Stauroneis Washingtonia* Mann, sp. nov.; 4, *Navicula subovalis* (Cl.) Mann; 5, *Navicula cuneicephala* Mann, nom. nov.; 6, *Navicula torta* Mann, nom. nov.; 7, *Stauroneis Washingtonia* Mann, sp. nov. (detail of fig. 3).



MANN on DIATOMS

THE GEOGRAPHIC AND HISTORICAL EVIDENCE

LAURENCE LAFORGE, GEOLOGICAL SURVEY

INTRODUCTION

The problems of the origin, structural relations, and age of the muck bed containing the cypress stumps are essentially geologic, are not especially difficult, and require only ordinary geologic methods for their solution. The geologists who investigated the deposit recognized these facts and employed such methods, with the result that the evidence so obtained was abundant, plain, and unmistakable and enabled them to establish beyond question and by geologic methods alone that the muck bed is of great antiquity, humanly speaking, and that its age must be reckoned in tens of thousands of years. All geologists who examined the locality were agreed in this conclusion. Nevertheless many other persons, not appreciating the nature of the geological evidence and the certainty of the conclusions derived from it, and impressed by the nearly perfect preservation of the wood of the stumps, were skeptical of the age assigned by the geologists and preferred to regard the deposit as not more than a few score of years old.

This conclusion appeared to them to be supported by the topography of the locality and by its recent history. From Sixteenth street westward to New Hampshire avenue, L street lies in a depression which, within the memory of many old residents of Washington, was deeper than now and was the lower valley of a small stream named Slash Run—a tributary of Rock Creek. The boys and young men of 60 or more years ago caught frogs and small fish in this stream, swam in its deeper pools, and hunted rabbits and wild fowl in the reeds and brush along its banks. When the streets of that part of the city were graded a trunk sewer was built to carry the water of Slash Run and its channel was filled in, as was the adjacent low ground, in some places to a depth of 10 or 12 feet. The square bounded by De Sales, Seventeenth, and L streets and Connecticut avenue became the grounds of the Academy of the Visitation, and the building of the Academy was erected on the west end of the lot. Its north end, which was within the present hotel site, stood on filled ground over the former course of Slash Run. This building was razed several years ago and its cellar filled in.

In 1922, when the muck bed and cypress stumps were exposed in the excavation for the hotel and the geologists had announced their conclusion regarding the age of the deposit, many persons, who remembered or had heard of Slash Run and that considerable filling

had been done along its former course, hastily concluded that the plant remains were merely those of trees and other vegetation that had grown there since the settlement of the city and had been buried but a few years. In support of this contention speeches were made in meetings of local societies and letters were written to local papers, and at least one article was written by a scientific man and published in a periodical of national circulation. The arguments of all who supported this view were deficient in that they were based on oral traditions, boyhood recollections, and similar hear-say evidence and not on authenticated documentary records. Many of the arguments were also quite irrelevant and most of them completely disregarded the facts that were plainly revealed in the excavation. Hence it seemed to be desirable, to convince others of the soundness of the geologic conclusions, for the geologists to reinforce the evidence from the facts displayed in the excavation with the available geographic and historical evidence. Such evidence, on investigation, proved to be as abundant, unequivocal, and convincing as the geologic evidence and to be in entire agreement with it.

HISTORICAL EVIDENCE

The historical evidence is largely negative, that is, it is not so much directly confirmatory of the conclusions of the geologists regarding the age of the deposit as it is opposed to the conclusions of those advocating the other view. There is much historical evidence about Slash Run, the topography of its valley, and the conditions along its course, but none of any swamp along it below Massachusetts avenue, although there may have been marshy ground along the left bank of the stream in the neighborhood of Sixteenth and L streets, and along the right bank at Connecticut avenue and again between Nineteenth and Twentieth streets. In this lower part of its course the stream was mainly clear and flowed over a sandy or gravelly bed between banks 5 to 8 feet high and a few yards apart. The swimming-holes remembered by so many persons were probably partly artificial, as one of the old residents of the city has stated that such holes were dug in the bed of the stream for the use of soldiers camped in the city during the Civil War.

The stumps found in the muck bed are those of bald cypress, and the great number of stumps and the abundance of cypress leaves and seeds in the muck leave no room for doubt that the bed is the remains of a former cypress swamp. Bald cypress does not now grow naturally

in the District of Columbia nor within several miles of its boundaries and the nearest cypress swamp is in southern Maryland, about 100 miles south of Washington. There is no record of bald cypress having been found growing naturally in the District since the first visits by white men. It is not mentioned in the earliest check lists of the plants of the District, which were compiled more than a century ago, nor in any lists except those of very recent years which cover a considerable territory outside the District. Of those old residents of the city who remember playing along the banks of Slash Run in their youth, and some of whom insist that the stumps found in the excavation are those of trees growing there only 60 years ago, not one professes any recollection of a cypress swamp or of cypress trees or stumps in that locality. In a description, published in 1861, of the part of the city traversed by Slash Run, sweetgum, maple, and magnolia are enumerated as growing in or about the wetter places, but no mention is made of bald cypress. These facts alone ought to be sufficient evidence that the deposit is not the remains of a swamp that existed on the surface within the memory of men still living.

Furthermore, early records and descriptions of Washington contain several references to the finding of logs and pieces of trees, some of them nearly perfectly preserved, in digging cellars and wells during the settlement of the city, but there is no record of the species of the trees dug up and no indication that any of them were bald cypress. Such remains were found in several places and at various depths, even 48 feet below the surface, and as they were discovered before the streets had been graded and the contour of the surface changed by cutting and filling there can be no suspicion of their having been buried artificially. The records of these early discoveries dispose of the argument that such well preserved tree remains must necessarily have been buried artificially but a few years ago.

Finally, the muck bed found in the Walker Hotel excavation is by no means so unique as many people have supposed. What is presumably the same bed was encountered, at the same depth, in excavating for the foundations of Stoneleigh Court, a large apartment house built a number of years ago on the east side of Connecticut avenue about 100 yards south of the Walker Hotel. Apparently the top of the same bed was exposed, though no stumps were reported, in digging the cellar of the Rauscher building, across Connecticut avenue from Stoneleigh Court. A similar bed must have been exposed somewhere in the city many years ago, as a brief account of the geology

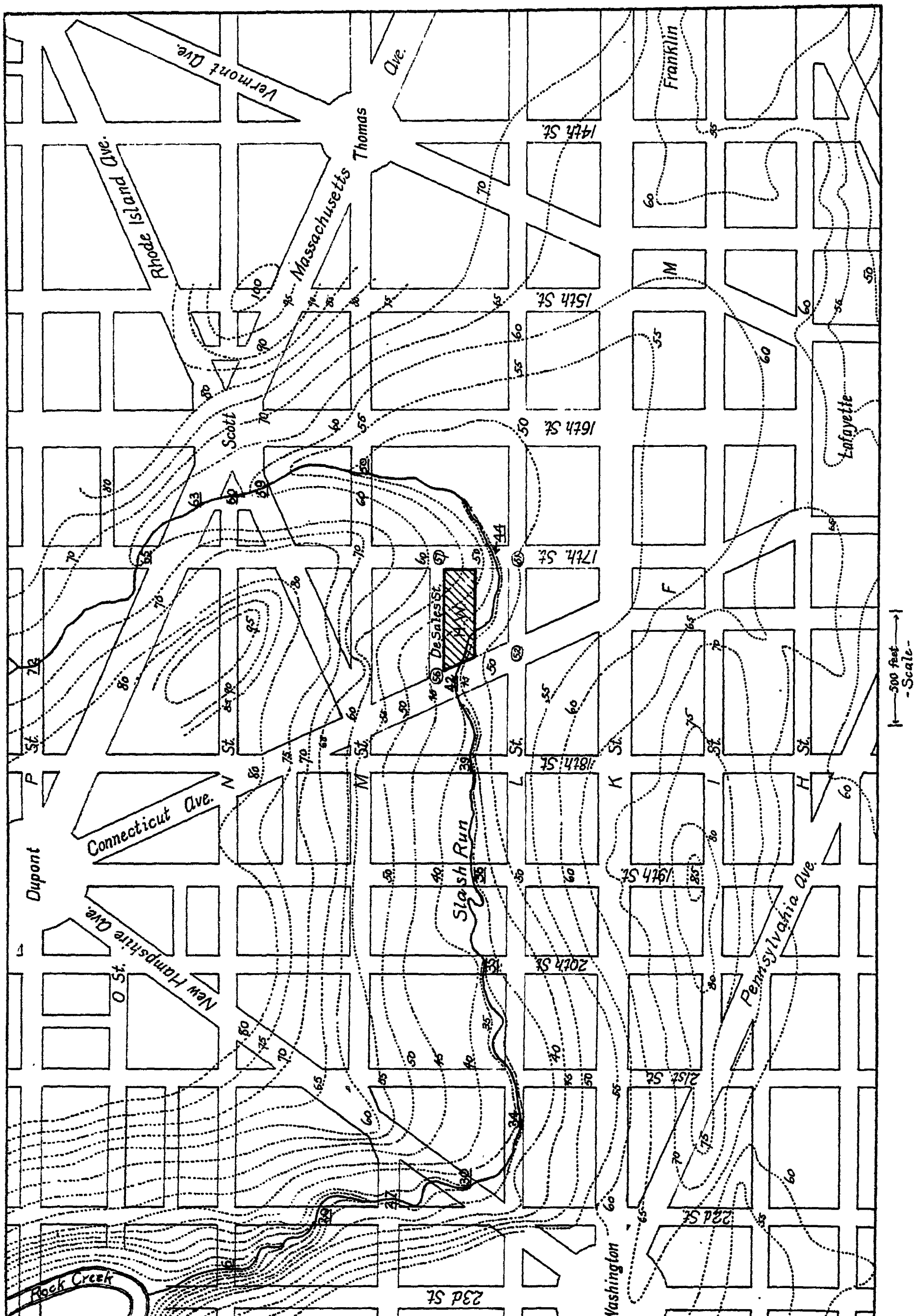


Fig. 1. Generalized contour map of the lower part of Slash Run valley as it was when the city of Washington was laid out. (For explanation see body of text.)

of Washington, written before 1860, in describing the strata upon which the city is built, mentions beds of peat and other vegetal material, interstratified with beds of gravel, sand, and clay.

GEOGRAPHIC EVIDENCE

When the city of Washington was laid out the relief of the land now occupied by it was greater than at present and many features have since been obliterated by the grading of streets, cutting down of knolls, and filling up of ravines. No contour map of the original surface was made and the contours on the oldest existing contour map of the city proper, which was made in 1863, after the surface had been considerably modified, were drawn mainly with reference to established street grades and with little regard to the form of the surface inside the squares. However, early in the nineteenth century, after the streets had been surveyed and opened through the woods and brush, lines of leveling were run along the centers of all the streets and the altitudes of the street intersections and of other important points in the streets were determined, as a preliminary step to the establishment of grades. The altitudes were plotted on a large-scale street map which is preserved in the office of the District Engineer of Highways, and material is thus available for the construction of a contour map that will show approximately the relief of the original surface. Several published maps made from early surveys show accurately the former courses of the small streams, but no one seems to have thought it worth while to map the positions and outlines of the swamps.

Figure 1 is a map of the part of the city in which the Walker Hotel is situated, showing the former course of Slash Run and, by five-foot contours, approximately the original form of the surface in the lower part of Slash Run valley. The contours were drawn partly by Dr. N. H. Darton, of the Geological Survey, and partly by the author, from data taken from the old map showing the original altitudes, mentioned in the preceding paragraph. They are, of course, constructed by interpolation, but are accurate for the points where they cross the streets, though necessarily only approximately located between the streets. The italic figures give the altitude of the contours above sea level, the underscored figures the altitude of the bed of Slash Run where it crossed the streets, and the figures in circles the present altitude of street intersections near the site of the hotel, which is the diagonally cross-lined space.

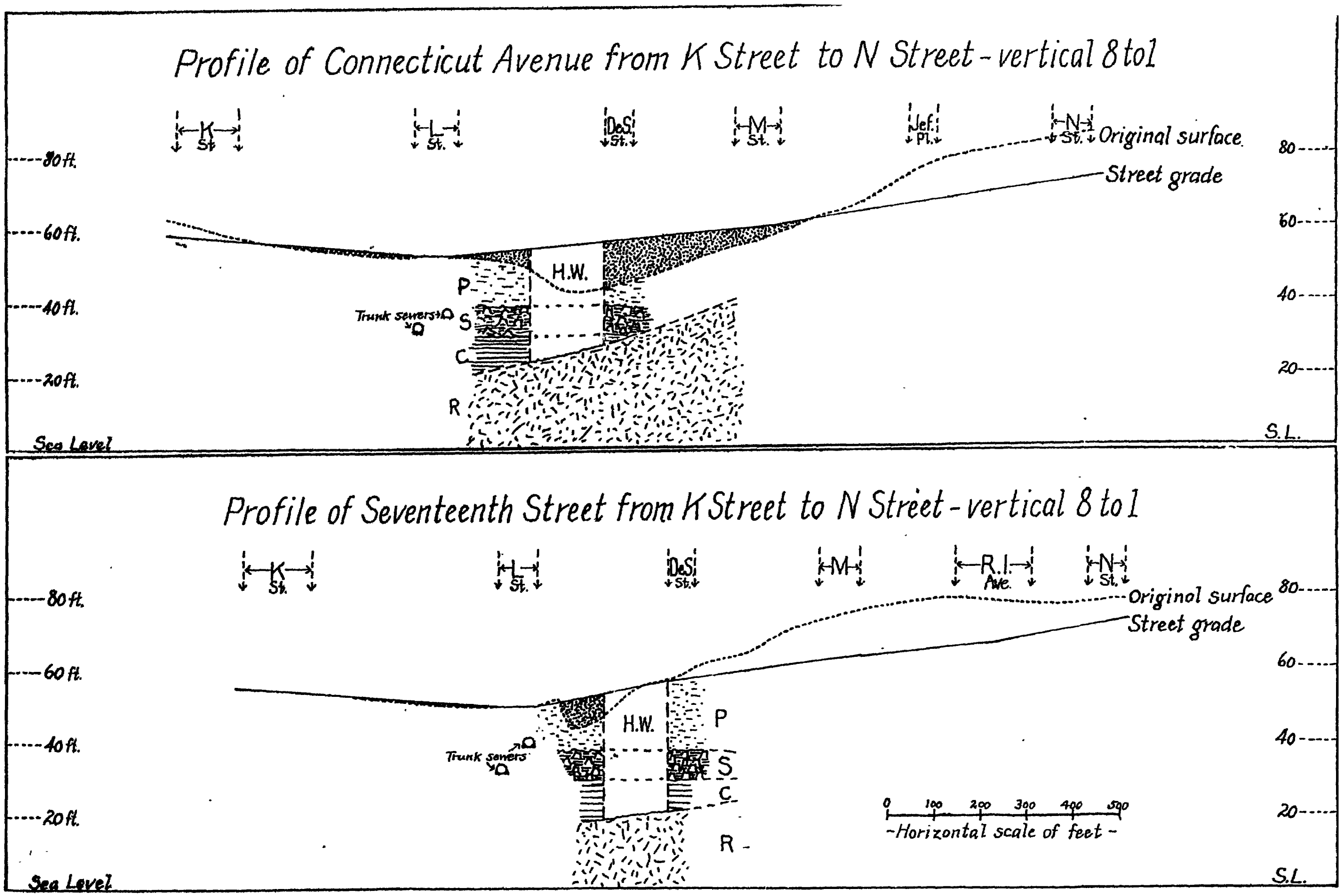


Fig. 2. Profiles showing the relation of the present and original surface in the vicinity of the Walker Hotel. H. W.—Walker Hotel P—Wicomico formation (Pleistocene); S—Stump bed and muck layer (Pleistocene); C—Patuxet formation (Cretaceous) R—Crystalline rock (Pre-Cambrian).

This map shows that in the vicinity of the hotel site there was a rather steep descent from Rhode Island avenue to the north bank of Slash Run and a more gentle rise from the south bank of the stream to I street, and that the stream flowed through the area now occupied by the hotel in a ravine in which there was no room for a swamp. It also shows that through most of its lower course the fall of the stream was too rapid for the formation of a swamp. In two places, however, one east of Seventeenth street and the other west of Nineteenth street, where the valley was wider and one bank of the stream was lower than elsewhere, the stream may have flooded the valley bottom during freshets and may thus have formed somewhat marshy areas. Finally, comparison of the present altitudes of the street intersections with the former altitude of the surface shows the amount by which the surface has been raised by filling. This ranges from nothing at the northeast corner of the hotel site to 12 feet at the northwest corner, but at one place in the channel of the stream the depth of fill shown in the excavation was about 15 or 16 feet.

The top of the stump bed is 16 to 20 feet below the present surface and as the depth of fill was nowhere greater than 12 feet, except in the stream channel and there only in deep holes, the stumps clearly can not be those of trees that were growing on the banks of the stream before the fill was made and within the memory of living persons. This is more clearly brought out by Figure 2, which shows two profiles, with a vertical exaggeration of 8 to 1, drawn along the centers of Connecticut avenue and Seventeenth street, respectively. The profiles show the present grade and the original surface and thus the amount of cut or fill, the fill being indicated by a stippled pattern. They also show the position of the hotel excavation, projected into the planes of the profiles, the positions and thicknesses of the geologic formations exposed, and the approximate position of the crystalline rock surface. They present incontestable evidence of the correctness of the conclusion of the geologists that the stump bed represents an ancient swamp that existed in a former geologic epoch, that was not exposed at the surface during the early history of Washington as a city, and that had no relation to Slash Run.

PHYSIOGRAPHIC RELATIONS

The muck bed was found at nearly the same level in all parts of the hotel excavation and has been encountered at that level on the south side of I street, 100 yards south of the hotel. It therefore underlay

parts of the surface that differed in altitude, before Slash Run was filled in, by at least 16 feet, and it must also underlie areas where there has been no fill. Hence it has no relation to the recent topography and must have occupied a hollow in a surface existing at some time during the Pleistocene epoch. As the average thickness of the bed is about 8 feet it must represent a swamp that was in existence for a long time. The swamp could have extended but a short distance northwest of the hotel site, as the muck bed was not encountered in excavating for the foundations of the Connecticut apartment house, at the southwest corner of Connecticut avenue and M street, where the crystalline rock surface was reached at no great depth. On the other hand it may have extended some distance southeastward, as there are indications of a shallow trough, trending in that direction, in the surface of the Cretaceous beds.

The cypress swamp must have been but little above the base level of drainage in the Potomac basin at that time. It probably occupied the lower valley of a tributary of the Potomac, perhaps the Rock Creek of that epoch, when the land stood 30 feet or so lower than now with regard to sea level, and when the uplift which caused the stream to excavate its valley had ceased and had been succeeded by a slow subsidence, which allowed the accumulation of 5 to 10 feet of swamp deposit. The subsidence then became more rapid and the swamp was buried by the beds of sandy clay and fine gravel constituting the Wicomico formation. After some later oscillations of level that did not materially affect the history of the Walker Hotel locality the Recent epoch was ushered in by an uplift of the land to a little more than its present height and the development of a new drainage on the emerged surface. Slash Run was formed and began to carve its valley, and it had almost but not quite uncovered the old stump bed when man interfered and put an end to its activities.

Buried muck and peat beds containing cypress stumps and wood have been found exposed in cliffs and river banks or have been penetrated in wells at many places in the Coastal Plain from Maryland to Alabama. Nearly everywhere they are overlain by deposits of the Talbot formation of the Pleistocene age and are believed to have been formed in the early part of Talbot time, hence the bed in the Walker Hotel excavation was at first regarded as of Talbot age. Later study led to the view that the overlying sandy clay is part of the Wicomico formation. Furthermore, its altitude above present sea level and its relation to the topography of Pleistocene time make it improbable that the bed can be as young as Talbot. It is now regarded as having been formed in the early part of Wicomico time and hence of mid-

Pleistocene age. Although the Pleistocene formations of the Chesapeake Bay region have not yet been satisfactorily correlated with the drift sheets of the northern United States, there is little doubt that a deposit of early Wicomico age must be older than the Wisconsin drift, if not, indeed, older than the Illinoian drift. The best recent estimates of the date of beginning of the Wisconsin glacial epoch put it not later than 100,000 years ago and the date of beginning of the Illinoian glacial epoch as at least 300,000 years ago. It seems fairly certain, therefore, that the muck bed and the cypress stumps can not well be less than 100,000 years old and that they may be much older.

SUMMARY.

The conclusions of the geologists as to the great age of the stump bed, based on the stratigraphic relations displayed in the excavation, have been confirmed in every respect by the testimony of the leaves, seeds, and diatom remains found in the muck, by the physiographic evidence of the conditions under which the cypress swamp was formed and existed, by the geographic evidence regarding the topography of the lower valley of Slash Run, and by the historical evidence from descriptions published years before the growth of the city had altered the conditions in the locality. It is, therefore, established that the stumps and the muck in which they are imbedded are the remains of a cypress swamp that was overwhelmed and buried by natural processes many thousand years ago and are not, as so many people have supposed, the remains of trees that grew on the banks of Slash Run less than 60 years ago and were cut down and covered by an artificial fill.

It should be said in closing that the geologists make no demur to the recollections of the old residents, but only to the conclusions based on those recollections. The geologists are well aware and admit without question that a stream formerly ran through the locality in a valley that was deeper than it is now; that there may have been marshy spots here and there along its course; that large trees grew on its banks; and that the trees were cut down and the land was filled to some depth about 50 years ago. They insist, however, and have proved, that all this has nothing to do with the muck bed and cypress stumps discovered in the Walker Hotel excavation, at a depth several feet below the bottom of the former Slash Run valley, and that the stump bed is a much older deposit in no way related to the conditions along Slash Run that many people still remember.

Obituary

Mr. ERSKINE DOUGLAS WILLIAMSON, physicist in the Geophysical Laboratory of the Carnegie Institution of Washington, and one of the Editors of this *Journal*, died on Christmas afternoon at about three o'clock at the George Washington University Hospital.

Although only thirty-seven years of age at the time of his death, Mr. Williamson had won for himself an eminent position not only in the scientific life of Washington, but in a wide circle of mathematical physicists and physical chemists in this country and abroad. He was born in Scotland on April 10, 1886, and was educated at the University of Edinburgh, where he took the degrees of Bachelor of Science in 1908 and Master of Arts in 1909. As one of the most promising pupils of Sir James Walker, he was appointed a research assistant under the Carnegie Trust of Scotland. His research work at Edinburgh became known in this country and he was offered an appointment at the Geophysical Laboratory of the Carnegie Institution in 1914. Here, in company with John Johnston and L. H. Adams, he studied the problems of the formation and consolidation of limestone. This work was followed up by research on the physical and chemical effects of very high pressures, in which he did pioneer work in the development of special apparatus and in the measurement of compressibilities of minerals and rocks.

During the War he did his part in aid of the cause of his native country, as well as of the United States, by going into one of the glass plants, in company with other members of the Laboratory force, and assisting in the rapid development of the manufacture of optical glass, a "key industry" in which this country rapidly shook itself free of its former dependence on Germany.

Mr. Williamson's ability as a mathematician was particularly highly valued at the Laboratory, and he made several valuable contributions to the practical problems of the annealing of glass, as well as to the theoretical and highly important question of the transmission of earthquake waves through the earth, and the deductions concerning the constitution of the earth's interior, which can be drawn from these facts.

Mr. Williamson was active in the local scientific organizations, having been a member of committees in the American Chemical Society and the Philosophical Society of Washington, and one of the editors of the *Journal* of the ACADEMY, of which he would have become Senior Editor in January. He was also a member of the American Physical Society and the Mathematical Society of Edinburgh.

The Editors wish to put on record their appreciation of his self-sacrificing devotion to the editorial work of the *Journal*, which he continued until forced by illness a few weeks ago to relinquish the duties, and of their own keen sense of loss in the sudden death of their colleague.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 14 JANUARY 19, 1924 No. 2

ENTOMOLOGY.—*A new* Prorhinotermes *from Panama.* T. E. SNYDER, Bureau of Entomology.

J. Zetek and I. Molino of this Bureau, stationed at Ancon, Canal Zone, have recently collected a species in the genus *Prorhinotermes* Silvestri, which proves to be new. This new termite (*Prorhinotermes molinoi* Snyder) was found on Largo Remo Island, Canal Zone, on the Atlantic Coast. With the addition of this new species, the known termite fauna of Panama totals 30 species, representing 18 genera or sub-genera. The termites of Panama are of great biological interest; three families are well represented, but the Termitidae are the most numerous. Since the forming of Gatun Lake some species are apparently now confined to virgin islands in this lake.

Species of *Prorhinotermes* apparently are not subterranean in habit. In burrowing through wood the grain is followed; the hardest species of woods are riddled.

Prorhinotermes molinoi, new species.

Winged adult.—Head greyish-brown, darker than *P. simplex* Hagen; spectacle markings on epicranium, but slightly longer than broad, slightly broader posteriorly than anteriorly, with few scattered long hairs—3 transverse rows.

Fontanelle distinct, hyaline, sub-oval spot, on line at posterior of ocelli. Eyes black, nearly round, large, projecting, less than their diameter from lateral margin of head, a little less than twice their diameter from the posterior margin of the head. Ocelli hyaline, subelliptical, narrow, pointed at apex, nearly touching eyes, at oblique angle to eyes, nearly parallel to upper margin of antennal socket. Post-clypeus lighter colored than head, bilobed, projecting. Labrum lighter colored than head, arched, tongue-shaped, broader than long, broadest beyond central transverse line, with long hairs at apex.

Antennae yellow-brown, 17 or 18 segments, pubescent (long hairs); third segment is shorter and narrower than second or fourth segments; segments are wedge-shaped, but become broader and longer towards apex; last segment elongate and subelliptical.

Pronotum same color as head, broader than long, anterior margin slightly (concave) roundedly emarginate, sides roundedly taper to posterior margin, which is convex; with scattered long hairs on margins.

Legs yellow brown, fairly elongate, pubescent.

Wing scale plainly longer than the pronotum.

Wings hyaline, costal veins yellowish, base blackish, over twice as long as the abdomen. In forewing, there is no definite median vein, but the cubitus branches in the middle into two branches, the upper branch may be considered the median vein; it is above the cubitus, parallel to the subcostal vein, is unbranched, and nearly reaches the apex of the wing; the lower branch branches to the lower margin, there being from this and direct from the cubitus 17 branches or subbranches to the lower margin of the wing. In hind wing, the median is more distinct, and runs parallel and close to the cubitus until near the apex of the wing, where it branches to the subcosta; the cubitus reaches the apex of the wing, and has 17 branches or subbranches to the lower margin (Figs. 1 and 2).

Abdomen dorsum same color as pronotum, ventrally lighter colored; with row of long hairs at base of each tergite. Cerci fairly elongate.

Measurements:

Length of entire winged adult: 9.50 mm.
Length of entire dealated adult: 5.0–5.5 mm.
Length of head: 1.50 mm.
Length of pronotum: 0.77 mm.
Length of anterior wing: 7.50 mm.
Length of hind tibia: 1.17 mm.
Diameter of eye: 0.32 mm.
Width of head: 1.40 mm.
Width of pronotum: 1.10–1.20 mm.
Width of anterior wing: 2.30 mm.

Prorhinotermes molinoi Snyder has a larger head than *P. inopinatus* Silvestri of the Samoan Islands, and a larger pronotum and different wing venation than *P. simplex* Hagen of the West Indies and Southern Florida; it differs from *P. oceanicus* Wasmann of the Cocos Islands in that *P. oceanicus* has 22 segments to the antennae and differs in wing venation. Wasmann states in an appendix (p. 160)[1] that *P. oceanicus* is the winged adult of *Leucotermes insularis* Wasmann from the Cocos Islands. Holmgren,[2] however, considers *oceanicus* to be in the genus *Prorhinotermes.*

Soldier.—Head yellow-brown, slightly darker anteriorly, much broader posteriorly than anteriorly, with few scattered long hairs in several transverse rows; fontanelle hyaline spot (distinct) on line at center of eye spot. Eye spot hyaline, large, suboval. Labrum yellow-brown, elongate, rather narrow and rounded at tip, with long hairs at apex.

Mandibles dark reddish-brown, heavier and broader even to apex (less taper) than in *P. simplex* Hagen.

[1] 1903. WASMANN, E. *Über einige Termiten von Oceanien.* Zool. Jahrb. Band 17, Heft 1, Anhang 10: 139–164.

[2] 1910. HOLMGREN, N. *Termitienstudien.* Kungl. Sv. Vet. Akad. Handling., Band 46, no. 6: 73, *pl. 5, f. 11.*

Antennae yellow-brown (broken), pubescent; third segment subclavate, longer than fourth, but slightly shorter than second segment; segments wedge-shaped.

Maxillary palpi very long and slender; as long as mandibles.

Pronotum slightly darker than head, broader than long, broadest near anterior margin, slightly concave, sides roundedly taper to posterior margin, which is nearly a straight line.

Legs light yellow-brown, fairly elongate and slender, pubescent.

Abdomen yellow-brown, with row of long hairs at base of each tergite.

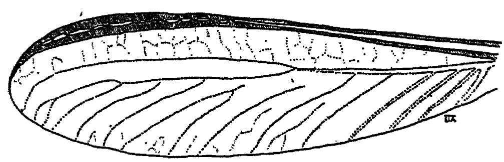


Fig. 1 fore wing

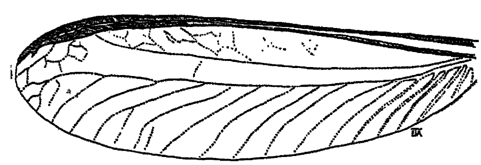


Fig. 2 hind wing

Measurements:

Length of entire soldier: 5.75–6.20 mm.
Length of head with mandibles: 2.90–3.00 mm.
Length of head without mandibles (to anterior): 1.90 mm.
Length of left mandible: 1.15–1.20 mm.
Length of pronotum: 0.70–0.80 mm.
Length of hind tibia: 1.20 mm.
Width of head (posteriorly where broadest): 1.60–1.65 mm.
Width of head (at anterior margin): 1.0–1.1 mm.
Width of pronotum: 1.20–1.30 mm.

Prorhinotermes molinoi Snyder has a larger head than *P. inopinatus* Silvestri and is longer than *P. simplex* Hagen.

Type locality. Largo Remo Island, Canal Zone, Panama, on the Atlantic Coast.

Described from a series of winged adults collected with soldiers and workers at the type locality by J. Zetek and I. Molino on August 31, 1923, in a hard, wet tree trunk on the ground. On the same day and on the same island winged adults, soldiers, and workers were found under the bark of a fallen coconut palm tree. I take pleasure in naming this termite after Dr. I. Molino, who has collected many interesting termites, and made valuable notes on their habits.

Type, *winged, male adult.*—Cat. No. 26756, U. S. N. M.; morphotype, soldier.

BOTANY—*The genus* Oxyrhynchus *Brandegee.* CHARLES V. PIPER, Bureau of Plant Industry.

In December, 1920, there were received from Miss Mary E. Woodbridge, State Department of Agriculture, Austin, Texas, seeds of a bean taken from plants grown near Austin by H. H. Parker, who reports that his original seeds were found in a lot of castor beans which the label on the bag indicated were imported from India. The seeds could not be identified, and so some of them were sent to Sir David Prain, at Kew, who forwarded a few to Colonel A. T. Gage, in Calcutta. Neither could identify the bean. Later, fairly complete botanical material was received from Miss Woodbridge. It proves to represent an undescribed species of the genus *Oxyrhynchus* Brandegee, which was based on a single species, *O. volubilis* Brandeg., collected by Purpus near Rascón, San Luis Potosí, Mexico. The specimens are in young flower.

The plant from Abaco and Cuba, described as *Dolichos insularis* Britton, also belongs to Oxyrhynchus.

On the basis of the more complete material the genus may be redescribed as follows:

OXYRHYNCHUS Brandegee

(*Leguminosae—Papilionacae—Phaseoleae—Phaseolinae*)

Twining herbs, perennial; leaves trifoliolate; stipules striate; flowers in axillary narrow raceme-like thyrses; bracts subulate, striate; bracteoles ovate; calyx bilabiate, campanulate, the rounded lobes subequal; standard reniform, broader than long, deeply emarginate, with two reflexed auricles at base; wings free, as long as the keel; keel broadly falcate, with narrowed acute beak, the two petals partly united, minutely ciliate; stamens diadelphous, the filaments glabrous, slightly enlarged at base; ovary linear, pubescent; style glabrous except near the apex, where bearded on each side with long hairs, and at tip, bearing similar hairs which partly surround the stigma; stigma ellipsoid-obovoid, attached on the dorsal side just below the middle; pods short-pedicelled, straight, cylindrical, beaked, terete or compressed, thin-walled, 2 or 3-seeded; seeds globose, each with a linear hilum extending over half the circumference of the seed, the hilum covered with a white caruncle; germination hypogeous.

Harms placed[1] *Oxyrhynchus* next to *Rhynchosia*, but it clearly belongs close to *Dolichos*, *Vigna*, and *Dysolobium*, as Dr. Harms points out in a recent letter.

[1] *Die Nat. Pflanzenf.* Erganzungsheft **3:** 149.

Apparently there are three species involved, certainly two, as the Austin plant is quite distinct from the others in its swollen pods. These species may be distinguished by the following key:

Pods turgid, circular in cross section; leaflets thin; inner layer of pod felt-like .... 1. *O. alienus.*
Pods compressed and 2-edged.
Leaflets thin, tending to coriaceous, 4–6 cm. long, truncate at base; flowers 8 mm. long; inner layer of pod thin ...... 2. *O. volubilis.*
Leaflets thickish, membranous, 4–7 cm. long, the middle one often subcordate; flowers 10 mm. long; inner layer of pod felt-like. 3. *O. insularis.*

1. **Oxyrhynchus alienus** Piper, sp. nov.

Perennial; stems herbaceous, twining, slender, terete, sparsely strigillose, tall, growing 15 to 20 meters in a season; petioles about as long as the leaflets, very slender, sulcate above, strigillose especially at the enlarged base; stipules triangular-lanceolate, acute, striate, persistent, 2.5 mm. long; stipels subulate, 1 mm. long; petiolules somewhat fleshy, puberulent; leaflets membranous, ovate-triangular, the lateral ones oblique, nearly truncate at base, obtuse and apiculate at apex, 3-nerved at base, sparsely strigillose on both faces especially beneath, 6 to 8 cm. long, 4 cm. broad; peduncles terete, axillary, strigillose, the inflorescences exceeding the leaves; flowers about 6 in each of 10 to 20 lateral clusters in a narrow, rather dense, raceme-like thyrse, the pedicellar glands oblong and prominent; bracts subulate, striate, fugacious, 3 mm. long; bracteoles ovate, thin, ciliate, 1 mm. long; pedicels short, puberulent; calyx purple, open campanulate, 5 mm. long, 2-lipped, the subequal lobes as long as the teeth; upper lip 2-lobed, the lobes semicircular, minutely ciliate; lower lip 3-lobed, the broadly oblong lobes rounded at apex, minutely ciliate, the median one two-thirds as long as the others; corolla green, more or less tinged with dull purple; standard green, butterfly-shape, deeply notched, 10 mm. long, 15 mm. broad, slightly pubescent on the back especially near the base, bearing a deep depression below the middle, broadly cordate at base, the stipe only as long as the sinus, each basal lobe with a blunt inflexed auricle; wing dull violet, as long as the standard, oblong, obtuse, sparsely ciliate, a broad triangular tooth near the base on the upper edge, the stipe one-third as long as the blade, the edges somewhat inflexed; keel green with the beak violet, lunate, semicircular, rather broad, the two petals attached to below the middle, the beak rather acute; stamens included, diadelphous; filaments filiform, glabrous; anthers innate; pollen yellow; ovary linear, pubescent; style curved, glabrous to near the tip, bearing long lateral hairs on each side just below the stigma; stigma terminal, dark green, obovoid, attached on the dorsal side below the middle, surrounded by long stiff hairs arising from the sides of the style tip a short distance below the stigma; pods inflated, oblong-cylindric, thin-walled, acutely short-beaked, densely covered with short somewhat ferruginous hairs, the two sutures prominent, a faint ridge on each valve very close to the ventral suture, 5 cm. long, 2 cm. broad, 2 or 3-seeded; pods lined inside with a thick soft felt-like layer

of white tissue; seeds spherical, dark brown, shiny, 10 to 12 mm. in diameter, the hilum linear, extending over half the circumference of the seed and covered with a dense white caruncle.

Orginally sent by Miss Mary E. Woodbridge, from plants grown by H. H. Parker, Austin, Texas, from seeds found in castor beans supposed to be from India. Type in the United States National Herbarium, nos. 1,111,336 and 1,111,337.

In October, 1923, when seen by the writer, the plant was just beginning to bloom. The roots are thickish, about the size of a lead pencil, but no nodules were found on the original plant nor on several seedlings examined. The herbage is not ill-tasting and probably would be palatable to cattle. The vine is quite attractive and when in bloom showy. It is well worthy of culture as an ornamental vine.

2. Oxyrhynchus volubilis Brandeg. Univ. Cal. Publ. Bot. 4:271. 1912.

In addition to the type specimens collected by Purpus and represented in several herbaria, the plant was collected in mature fruit at Victoria, Tamaulipas, Mexico, November, 1830, by Berlandier (no. 3129), the specimen being in the Gray Herbarium. Another specimen from the same place was collected by Dr. E. Palmer (no. 265), February 1 to April 2, 1907, also in mature fruit. Dr. Palmer notes that it is called "frijol monilla," and that the seeds are used as food and also by children in lieu of marbles. Both the Berlandier and Palmer specimens seem identical with the Purpus plant, and the two localities are not far apart. The mature pods are compressed, 6.5 cm. long, 3 cm. broad, and 1 cm. thick, each containing three nearly globose seeds, 10 mm. long. Pringle's 11333, collected near Monterey, Nuevo Leon, is in young flower.

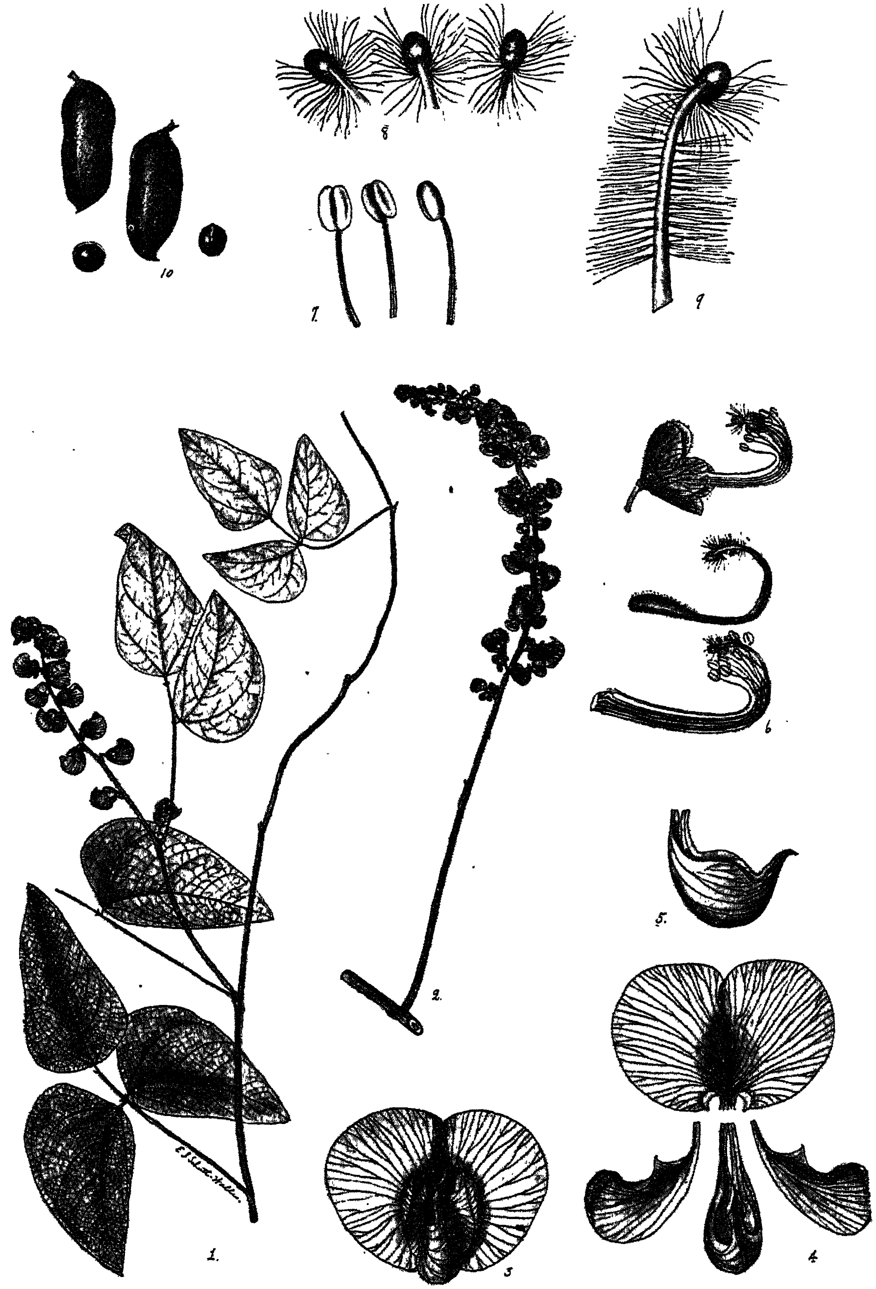
3. Oxyrhynchus insularis (Britton) Piper.

Dolichos insularis Brittton in Brit. & Millspaugh, Bahama Flora 195. 1920.

This plant is known from the following specimens:

Cuba: Cayo Ballenato Grande, Camaguey, *Shafer* 1026, March 22, 1909 (type); La Gloria, Camaguey, *Shafer* 255, February 3, 1909.

Abaco: Old fields, Great Cistern, *Brace* 1757, Dec. 19, 1904.



OXYRHYNCHUS ALIENUS PIPER

1. Branch of plant, × ½; 2. Inflorescence, × ½; 3. Front view of flower, × 3; 4. Separate petals of flower, × 3; 5. Keel, lateral view, × 3; 6. Calyx, stamens, and pistil, × 3; 7. Anthers, much enlarged; 8 and 9. Tip of style and stigma, much enlarged; 10. Pods and seeds, × ½.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE GEOLOGICAL SOCIETY

364TH MEETING

The 364th meeting of the Society was held in the Cosmos Club, Wednesday evening, November 23, 1921, President STOSE presiding and 49 persons present.

Informal communications: DAVID WHITE exhibited an unusual specimen showing joint-plane induration in sandstone, reported by Dr. I. C. White from northeastern West Virginia.

Mr. White also spoke on shaft and gallery mining of oil sand at Pechelbronn and in the Irvine pool of Kentucky. Discussion by Messrs. STOSE, ULRICH, BROOKS, BASSLER, and REINHOLT.

Program: J. S. BROWN: *Coastal ground water.* The contamination of wells by sea water on sea coasts is a problem of economic importance wherever the coastal population is dense and a large amount of water must be supplied, and has received attention in many parts of the world. This paper is based on a field study on the coast of Connecticut and on a review of the widely scattered literature on the subject. Statements regarding contamination are based on a large number of analyses, in which the amount of chloride (Cl) is the most important criterion.

In Connecticut shallow wells, such as are dug in the drift for domestic supply, seldom are contaminated at distances of more than 100 feet and never more than 250 feet from the shore. This corresponds with observations in other regions where rainfall is normal or abundant.

The deeper, drilled wellls in Connecticut usually penetrate bedrock and range from 100 to 500 feet in depth. They are contaminated more frequently than are shallow wells. The probability of contamination also increases with the depth, and when once salt water is encountered, fresh water is not likely to be obtained below. However, in places like the Atlantic Coastal Plain, where there are stratified sedimentary rocks, impervious beds often seal out salt water so that fresh water may be obtained even on islands or beneath the sea.

Contamination in Connecticut probably does not extend more than 500 feet inland, even at depth, because of the poor circulation of ground water in the fissures of the deeper zones in bedrock. However, on a sandy coast practically pure sea water may occur beneath fresh water even several miles inland, as has been shown by investigations in the dune belt on the coast of Holland.

Most islands appear to contain bodies of fresh ground water, generally only as a lens or thin sheet overlying salt water. The greater head of fresh water due to increment from rains enables it to displace a certain amount of salt water of greater density. On the basis of this equilibrium established between the fresh and salt water in porous materials such as sand, it is possible sometimes to predict the depth at which salt water will be found when the height of the water table above sea level is known.

Heavy pumping of wells near the sea frequently exhausts the fresh water faster than it is supplied, and causes the wells to become salty. Even a large drainage basin underlain by good water-bearing material such as the stratified drift of Connecticut can not be expected to yield more than about 25 per cent of the amount of water it receives by precipitation.

The salinity in certain wells on small islands and promontories sometimes is much greater in summer than in winter. A number of factors seem to combine to produce this effect. Diffusion and percolation are more rapid in summer. Evaporation is greater and transpiration by plants tends to reduce the quantity of water that reaches the water table. As a result, the salinity curve of wells in such localities shows a relation to the yearly temperature curve. (*Author's abstract.*)

E. O. ULRICH: *Solution of some vexing problems in Appalachian stratigraphy.*

W. T. THOM, JR., *Secretary.*

365TH MEETING

The 365th meeting was held in the Cosmos Club, Wednesday evening, December 14, 1921, with 55 persons present. The Presidential Address was delivered by the retiring President, GEORGE W. STOSE: *Relation of faults to folds in the Appalachians.*

W. T. THOM, *Secretary.*

At the 29th Annual Meeting, held on the same evening, the following officers were elected for the ensuing year: *President*, WM. C. ALDEN; *Vice Presidents*, G. F. LOUGHLIN and L. W. STEPHENSON; *Treasurer*, G. R. MANSFIELD; *Secretaries*, WM. T. THOM, JR., KIRK BRYAN; *Members-at-Large of the Council*, J. B. REESIDE, JR., R. C. WELLS, M. I. GOLDMAN, E. T. WHERRY, Miss A. I. JONAS.

LAURENCE LAFORGE, *Secretary.*

366TH MEETING

The 366th meeting was held in the Cosmos Club, Wednesday evening, January 11, 1922, President ALDEN presiding and 45 persons present.

Program: HERBERT E. GREGORY: *Geographic outline of the Southern Pacific.* Presented by T. WAYLAND VAUGHAN in the absence of Dr. Gregory.

T. WAYLAND VAUGHAN: *Correlation of the post-Cretaceous geological formations of the Pacific region.*

H. S. WASHINGTON: *Chemistry of Hawaiian Lavas.*

The 367th meeting was held in the Cosmos Club, Wednesday evening, January 25, 1922, President ALDEN presiding and 48 persons present.

Program: Prof. P. P. GOUDKOFF: *New aspects on the geology of the principal ore-bearing provinces of Siberia.*

JOINT MEETING

A joint meeting of the Washington Academy of Sciences and the Geological Society of Washington was held in the assembly hall of the Cosmos Club, Thursday evening, February 2, 1922, President HUMPHREYS of the Academy presiding, and 74 persons present.

Program: Prof. H. A. BROUWER: *The major tectonic features of the Dutch East Indies.*

368TH MEETING

The 368th meeting was held in the Cosmos Club, Wednesday evening, February 20, 1922, President ALDEN presiding and 63 persons present.

Informal communication: KIRK BRYAN—*Examples of wind erosion in the Plateau country of Arizona.*

Program: C. E. SIEBENTHAL: *Fluorspar district of Jardin County, Illinois.*

FRANK L. HESS: *Uranium-bearing asphaltite sediments of Utah.*

H. D. MISER and C. S. ROSS: *Diamond-bearing peridotite in Arkansas.*

369TH MEETING

The 369th meeting was held in the Cosmos Club, Wednesday evening, March 8, 1922, President ALDEN presiding and 62 persons present.

Program: FRANK REEVES: *A distant peripheral zone of thrust faulting in flat-lying beds around the Bearpaw Mountain intrusion, Montana.*

The regionally flat-lying Cretaceous formations which encircle the Bearpaw Mountains in Montana are highly faulted. These faults apparently are confined to a peripheral zone approximately 20 miles wide, which may be separated from the mountains by an unfaulted belt 8 to 10 miles wide. The larger faults are 10 to 20 miles long and have throws ranging from 1,200 to 1,500 feet. In a rough way they form arcs of circles circumscribed about the mountains. The chief characteristics of these faults are that on the upthrown side along a belt one-half to 1 mile wide the strata are usually highly inclined away from the fault, while on the downthrown side they lie at their regionally horizontal position. Other interesting features are the occurrence of pivotal faults—i.e., faults in which the throw changes sides along the fault plane—and the presence of long, narrow, rectangular, and smaller triangular horsts.

As many of these faults pass laterally into steeply dipping limbs of anticlines and as parallel with them there are long, narrow unbroken anticlinal folds, some of which are overturned, it seems evident that the faulting and folding are contemporaneous, and consequently that all the faults are either thrust faults or faults of slight hade. The few fault planes observed by the speaker, who mapped a portion of the faulted belt on the southeastern side of the mountains in the summer of 1921, were inclined toward the upthrown side at angles from 45° to 70°. The pivotal faults can be considered as thrust faults produced by the faulting of anticlinal folds along their axes. At one end of such a fault one limb of the anticline is faulted down, on the other end the other limb is faulted down.

Apparently these faults and folds were produced as a result of horizontal compression and as the deformed zone is so closely associated with the Bearpaw Mountains, these compressive forces probably originated in crustal movements in the mountains. These mountains, however, being a circular area of uplift consisting of a cluster of extinct volcanos whose breccia tuffs and flows rest upon a slightly elevated floor of Cretaceous shale, offer no obvious explanation of the origin of these compressive forces.

It is here suggested that beneath these mountains, at a depth of a few thousand feet, there is a laccolith, and that the intrusion of this laccolith domed up the overlying beds to a height of about 3 miles, and that later, either as a result of a sag in the earth's crust, induced by the weight of the laccolith, or by the escape of the magma upward through volcanic vents, the whole laccolith or the upper surface was lowered nearly 3 miles. (Such an elevation and subsidence would be necessary to produce a crustal shortening across the faulted zone of 2,500 feet, which is the amount estimated for the part of the faulted zone that was studied by the speaker.)

If this subsidence occurred, it is thought that the strata overlying the laccolith would be under great horizontal compression, for they would probably have been lengthened by the solidification of lava intruded into the tensional fissures caused by the uplifts, and could not settle back to a lower position without buckling. It is possible that the intrusion of igneous dikes and sills into the strata overlying the laccolith would so metamorphose and reinforce the strata that they would not buckle in the center of the dome but would transmit the compressive stresses out to the less rigid strata surrounding the mountains, and produce there the peripheral zone of faults.

The presence of dikes, sills, and small volcanic necks cutting Cretaceous rocks out as far from the mountains as the faulted zone suggests that the laccolith extended out under the faulted area in sill-like form. If it had such an extension and was not solidified when the collapse occurred, it would furnish a surface on which the domed beds could flatten without the development of a great amount of friction. In transmitting these compressive stresses the Eagle and Judith River sandstones, and probably the Madison limestone, if the laccolith were intruded below it, acted as competent beds. It is thought that the associated Claggett and Colorado shales under pressure would flow and give a vertical component to the horizontal compression stresses, which would explain why the strata are bowed up so sharply along the fault planes and why there are so many horsts or upthrown blocks. This flow of shales can be observed in some places in the field where the 600 feet of Claggett shale has been entirely pinched out, leaving the Judith River formation resting upon the Eagle sandstones.

That other laccoliths in the same region have not had such a history may be due to the fact that as a result of deeper burial or greater viscosity there was no upward escape of magma, or more probably that because of the larger size of the Bearpaw laccolith it alone of all the laccoliths in the western United States exceeded the load that the earth's crust could support. In support of such an explanation it may be noted that the larger laccoliths of the world have centripetal dips. (*Author's abstract.*)

W. D. Collins: *Fallacies regarding mineral waters.* It is generally admitted that a number of mineral waters have therapeutic properties. Some of the literature on the subject is thoroughly reliable, but erroneous or misleading statements may be found in the writings of those not specialists in the subject. Such errors are particularly apparent in attempts to correlate the composition of the mineral matter dissolved in a water with the therapeutic properties of the water. These properties have been attributed to the presence of traces of lithium, bromide, iodide, radium, or like substances, because such traces have been shown in analyses of the waters, and because the substances themselves are known to produce certain physiological effects. Such an explanation ignores the fact that no one could drink in a day the quantity of water which would contain an ordinary therapeutic dose of the unusual constituents. Furthermore, the water of many public supplies contains traces of these constituents so that such an explanation implies that millions of people are taking the medicine in every drink of water. It is not uncommon to describe the therapeutic action of ordinary substances such as calcium carbonate and bicarbonate or sodium chloride in connection with analyses of waters which contain no more of these constituents than can be found in many public and private supplies. All the statements regarding therapeutic action of the substances may be true, but the implied connection between the presence of these common constituents and curative properties of the waters is misleading. (*Author's abstract.*)

P. V. Roundy: *Upward migration of oil along a fault plane in Oklahoma.*

370TH MEETING

The 370th meeting of the Society was held in the Cosmos Club, Wednesday evening, March 22, 1922, Vice-President Louhglin presiding and 52 persons present.

Program: J. S. Diller: *The surface fusion of recent lavas.* (Illustrated.) In the remarkably progressive paper by Drs. Arthur L. Day and E. S. Shepherd on *Water and volcanic activity*[1] the important part played by water in volcanic eruptions was clearly demonstrated. It was also shown by them that as a magma rose in a volcano in consequence of the gradual release of pressure, dissolved gases were set free in constantly increasing quantity as the surfce is approached, and, especially near the surface, reactions were set up among the gases that increased the temperature in some cases locally at least more than enough to offset the loss of heat by expansion and exposure. The lava lake of Kilauea, apparently, is regarded by Day and Shepherd, and also by Dr. E. T. Allen, as maintained in a molten condition by such reactions.

A remarkable case of the fusion of lava after it reached the surface occurred in Salvador in connection with an eruption of basalt from the crater of El Pinar, June 7, 1917. Specimens of the lava were sent by Dr. S. Calderón, of San Salvador, to the U. S. Department of Agriculture. Dr. Calderón says, "The samples I am sending you were collected on the upper surface of the ground, in the pockets

[1] Bull. Geol. Soc. Amer. **24**: 573. 1913, reprinted in Ann. Rep. Smithsonian Inst. 1913 275.

of scoria formed by the escape of gases, being found on all very steep slopes where the current of lava formed casades." It appears that the lava flow in passing over the cascade was much broken and torn forming pockets into which the gases escaping from the lava collected and apparently mixed with the confined air. The reaction of the gases produced so much heat that the lava exposed on the inner surfaces of the pockets was fused. The fused basalt formed icicle-shaped bodies hanging from the roof from which the molten basalt dropped off to the floor or ran down the sides of the pocket. Although the lava in this case is basalt and fuses more easily than most other lavas the amount fused in the pockets appears to have been relatively small.

A similar phenomenon has been observed in connection with a late eruption of Lassen Peak. The lava is not basalt but dacite. About the volcanic vent from which the dacite was erupted May 19, 1915, on the joint plane surfaces in the new lava there are local patches of once molten material which appear to have been formed during the great explosive eruption of May 22, by rising hot gases escaping from beneath the surface along fractures into small pockets at the surface.

371ST MEETING

The 371st meeting was held in the Cosmos Club Wednesday evening, April 12, 1922, President ALDEN presiding and 53 persons present.

Program: M. N. BRAMLETTE: *The origin of the chert in the Oneota Dolomite.* The Oneota Dolomite of the basal Ordovician in Wisconsin contains much associated chert as nodules and lens-like masses parallel to the bedding-planes. This chert is a replacement of the carbonate rock, as shown by the exact similarity of micro-structure in the oolitic dolomite and oolitic chert, with a contact between the two showing all stages of the change, individual ooliths being partly of carbonate and partly of chert. Also, "cryptozoan" reefs, in which the chert occurs, show the organic micro-structure preserved by the replacing chert.

Evidence of the time of replacement is not conclusive. It seems to have been effected by marine waters as a syngenetic process; first, because the distribution is more suggestive of such a process, and secondly, because silicification was antecedent to dolomitization, as evidenced by the destruction of fossils by the latter process and their preservation where silicified before such dolomitization. Dolomitization of formations similar to the Oneota Dolomite is generally accepted as a syngenetic process effected by sea-waters. (*Author's abstract.*)

C. E. VAN ORSTRAND: *Deep earth temperatures.* (Illustrated.)

ARTHUR L. DAY and E. T. ALLEN: *The hot springs of the Lassen National Park.* (Illustrated.) These springs are regarded as volcanic in origin. The heat is doubtless volcanic as well as the gases which issue from the springs. The same may be said of a portion of the water, but the conditions prevailing satisfy none of the criteria which have been proposed for "juvenile" springs; most of the water is therefore probably meteoric.

The substances dissolved and precipitated in the springs are interpreted as decomposition products of the lavas of the region by free sulphuric acid which occurs in many of the waters. These substances

are opal, "kaolin," alunite, pyrite, and the sulphates of the common rock bases. The sulphuric acid is probably derived from the volcanic gases, hydrogen sulphide or sulphur.

Though most of the springs contain free acid a few are slightly alkaline. The alkaline condition logically represents a later stage of chemical reaction between the rock and dilute acid. These springs do not necessarily belong to a subsequent period; they may rather be the product of conditions locally favorable to more complete chemical action.

Hot acid springs of volcanic origin on chemical grounds are classified as a stage of volcanic activity that follows fumaroles and precedes alkaline springs. (*Author's abstract.*)

R. S. BASSLER: *Oscillation of the Central Basin of Tennessee in Ordovician time and its economic bearing.* (Illustrated.) The Carters, Lowville, and Kimmswick formations, of Black River age; the Curdsville, Hermitage, Bigby, Cannon, and Catheys formations, of Mohawkian age; and the Leipers formation, of Cincinnatian age, all rather easily distinguished faunally and lithologically, prove, in the course of extensive mapping, to be developed quite unequally on different sides of the Nashville dome. For example, the Carters limestone is thickest on the western side, while the overlying Lowville limestone is thickest on the eastern side; the Kimmswick limestone outcrops only on the southern flank; and the next younger formation, the Curdsville limestone, is found alone on the northern side. The chief reason for these differences is believed to be due to oscillation of the Nashville dome, and the great development of phosphatic rock in the Hermitage, Bigby, Catheys, and Leipers formations is considered as likewise connected with the same phenomenon.

DAVID G. THOMPSON: *Some features of desert playas.* (Illustrated.) The Spanish word playa is used to-day in Spanish-American countries to designate beaches along lakes, seas, or large rivers. Most English-speaking geologists, however, use the term to designate nearly level areas of alluvium in the lowest parts of closed basins in arid or semi-arid regions, which at times may be covered with temporary lakes and which are generally devoid of vegetation. This paper is based on observations of some 30 playas in the Mohave Desert region, California.

Most playas can be separated into two groups, depending upon the position of the water table. In water-tight basins the water table will always be within a few feet of the surface, and ground water is carried upward by capillary movement and discharged by evaporation and transpiration. The playas in these basins are kept moist almost continually by the capillary discharge, and, lacking a better term, they are tentatively called wet playas. If part of the rim of the basin is not water tight, ground water may move freely from one basin to another, and in the higher basin the water table may lie at a considerable depth. Playas in such basins are moistened only occasionally by storm waters and are dry for most of the time. These playas are tentatively called dry playas.

The dry playa has a water table generally deeper than 8 feet; the surface is hard and smooth in the dry season, with or without mud cracks; and there is generally less than 2 per cent of alkali in the soil. The wet playa has a soft, rough, and perennially moist surface; mud

cracks are generally absent; and alkali is present in the soil in amounts over 2 per cent and easily visible. These characteristic features seem to be directly related to the ground-water conditions in the enclosing basins. Observations of these surface features will generally enable the geologists to determine whether or not ground water is close to the surface.

Mechanical analyses were made of a number of samples, and a rough microscopic examination of them was made by Dr. M. I. Goldman to determine whether the soil of playas of the wet type contained more sand than those of the dry type, as seemed to be true in the field. The results did not show any unusual abundance of sand in the soils from the wet playas. The samples from several wet playas, however, showed unusually high percentages of very fine clay. In three samples from dry playas the greater proportion of the fine material was between 0.02 and 0.005 mm. in diameter. In four samples where the water table is known to be or is believed to be close to the surface a very large proportion of the material was much finer, in two of the soils 45 and 66 per cent, respectively, of the entire sample being finer than 0.0005 mm. It is suggested that the greater percentage of very fine material in the soils from the wet playas may be due to more effective chemical decomposition than where the water table is at some distance below the surface. Possibly some of the concentration of clayey material of the dry playa in the larger size is due to the fact that aggregates of the finer material have not been properly dispersed. (*Author's abstract.*)

372D MEETING

The 372d meeting was held in the Cosmos Club, Wednesday evening, April 26, 1922, President ALDEN presiding and 46 persons present.

Program: F. E. MATTHES: *The production of steps in canyons by selective glacial quarrying.* (Illustrated.) A critical study of the features of the Yosemite Valley, the Evolution Valley, and other glaciated canyons in the Sierra Nevada discloses the fact that the cross cliffs in their stairwise ascending floors consist, as a rule, of sparsely jointed, prevailingly massive rocks, whereas the basined treads are developed in relatively well jointed rocks.

The intimate relations that thus are seen to exist between form and structure can scarcely be explained by any of the more generally current theories of glacial excavating. The two theories that have been applied to the interpretation of the development of the Yosemite Valley—the frost sapping theory of Willard D. Johnson and the gravitational corrasion theory of E. C. Andrews—both postulate rapid headward recession of cross cliffs under the influence of sapping processes acting intensively at their bases. The treads of the stairway are supposed to result from this recession, which, for reasons not adequately explained, is assumed to work horizontally, or nearly so. However, it is manifest that the cross cliffs in the Sierra canyons are developed under structural controls of a purely local nature, and therefore are not migrant but essentially stationary features.

It is believed that the evolution of steps in glaciated canyons is better explained by a theory of *selective quarrying,* according to which the ice would excavate most effectively where the rock is most thoroughly jointed and therefore most readily quarried away block

by block, and would excavate least effectively where the rock is massive and not susceptible of being quarried. In a canyon floor composed of alternating stretches of jointed and massive rock, therefore, selective quarrying would in time produce a series of shallow basins separated by barriers of massive rock. However, the barriers are slowly planed down by grinding on their upstream sides and crests, and the basins are quarried out most energetically at their heads, where the glacier falls into them, and so, the asymmetry of both barriers and basins becomes progressively accentuated, and there results a canyon profile resembling a stairway with basined treads.

Abundant proof of the local origin and essentially stationary character of the cross cliffs is afforded by their peculiarities of form, declivity, and orientation, which are in every case clearly determined by the structural peculiarities of the rock. Particularly instructive in this regard are the cross cliffs at the heads of the Yosemite and Evolution valleys. They cut obliquely across the valleys, regardless of the direction of the motion of the ice, but strictly in accordance with the local structures.

ARTHUR HOLLICK: *A review of the fossil flora of the West Indies.* Comparatively little is known and still less has been recorded in relation to the fossil flora of the West Indies. The bibliography is very scanty. Ward,[2] in his comprehensive paper on *The geographical distribution of fossil plants*, issued in 1889, gives a list of eight titles, and states that "the only one of the West Indies from which fossil plants have been reported is the island of Antigua." A recent thorough search through all the available literature on the natural features of the region has resulted in the compilation of a list of only sixteen titles in which there were any descriptions of or references to fossil plants, and many of these include mere incidental references to the presence of fossil plant remains without any descriptive text or illustrations. The only islands in connection with which fossil plants are mentioned are Cuba, Jamaica, Haiti, Porto Rico, Antigua, Martinique, and Trinidad. Collections made within the past three or four years are being studied, and the publication of the results will add considerably to the meagre information heretofore available. All of the specimens included in the several collections mentioned have been figured, and many of the descriptions have been written. It is expected that a contribution will be ready for publication in the near future which will include all that is known at date in regard to the fossil flora of the entire West Indies. (*Author's abstract.*)

WENDELL P. WOODRING: *Tectonic features of the Republic of Haiti and their bearing on the geologic history of the West Indies.* The West Indian region belongs to the zone of Alpine folding that outlines the track of the late Mesozoic and Tertiary equatorial geosyncline. In the Republic of Haiti there were three periods of folding, at the close of Cretaceous time, at the close of Eocene time, and at the close of Miocene time. The geographic and tectonic features of the entire central part of the Republic, of the northwestern peninsula, and in part of the southern peninsula are due to the folding and crumpling of the rocks at the close of Miocene time. In some parts of the Republic the folding that began at the close of Miocene time has con-

[2] Ward, L. F., U. S. Geol. Surv. 8th. Ann. Rep. 1866–87[2]: 663–690. 1899.

tinued to the present time. In these regions Pleistocene reef caps are symmetrically arched over the crests of older arches. In the northwestern peninsula the Pleistocene reef caps have an altitude of 400 to 450 meters above sea level on the crest of the arch.

The most striking feature of the present morphology of the West Indies is the series of arcs, which are convex northward and southward. The great submerged troughs, such as the Bartlett trough, Brownson trough, and Anegada trough, have been interpreted by Vaughan and Taber as down-faulted blocks bounded by normal faults. Accumulating evidence shows that these submerged troughs were deepened, if not formed, at the close of Miocene time and during Pliocene time. It would be difficult to account for the tension demanded by the block-fault hypothesis at any time, but it would be particularly difficult to account for it at the same time when similar subaerial features were being formed in the Republic of Haiti by the folding and crumpling of the rocks. The Cul-de-Sac plain, Artibonite valley, and Central plain are deep subaerial troughs. All of these subaerial troughs are synclines and some of them are bounded by a zone of imbricate high-angle thrust faults. It seems more reasonable to believe that the submerged troughs are similar tectonic features. (*Author's abstract.*)

KIRK BRYAN, *Secretary.*

THE BIOLOGICAL SOCIETY

656TH MEETING

The 656th meeting was held in the lecture hall of the Cosmos Club November 10, 1923, at 8 p.m., with Vice-President Gidley in the chair and 103 persons present. The program was as follows:

W. B. GREELEY. Chief, U. S. Forest Service: *The relation of National Forest management to wild life.*—The National Forests include a large part of the breeding grounds and range of American big game. A game census by Forest officers, though it has obvious limitations, gives a fair idea of the importance of this resource in its total of over 515,000 of the larger ruminants. No management of these areas is sound or far-sighted which does not recognize wild life as one of their major resources, to be fostered and wisely used exactly as timber and forage. The Forest Service is working toward an ultimate policy of real game management, whose main points are: replenishment or restocking of areas depleted of game; maintenance of a normal game population; rational methods of utilizing the natural increase of a normal game stock; total protection of rare or distinctive game animals; complete protection of wild life, except predatory species, on special areas.

The next step in advancing the interests of game as a primary resource of the National Forests should be the enactment of a general law authorizing the establishment of game and fish refuges by Executive Order, with State concurrence. (*Author's abstract.*)

L. O. HOWARD, Chief, Bureau of Entomology: *A recent visit to certain European centers.* The speaker described his visit to Europe during the past year and showed views of the buildings and some of the principal workers at the following institutions: the Liverpool School of Tropical Medicine, the London School of Tropical Medicine, and the Wellcome Research Labora-

tory. The buildings at Hyères, maintained as a laboratory for work on insect parasites by the U. S. Department of Agriculture were also shown. An interesting account was given of Dr. Howard's visit to Dr. Grassi, the Italian worker on malaria, at Fumacino. The talk closed with pictures of the delegates to the International Conference of Phytopathologists and Economic Entomologists at Wageningen.

657TH MEETING

The 657th meeting was held at the Cosmos Club November 24, 1923, at 8 p.m., with Vice-President Oberholser in the chair and 44 persons present. The following persons were elected members of the Society: Edward Elliott, Mrs. Edward Elliott, Harry Harris, A. G. Johnson.

Under *Short Notes*, E. A. GOLDMAN reported his observation of a California Condor at the west entrance of General Grant National Park, Tulare County, Calif., October 11, 1923.

L. O. HOWARD spoke of an interesting lecture on metallic colors recently given at Ithaca by Prof. WILDER BANCROFT.

F. C. LINCOLN reported that 500 returns of banded birds have been received up to October 1. Among the most interesting records are those of three Pintails banded in the Mississippi Valley and recovered in California, and of a Green-winged Teal banded in Louisiana and recovered in California.

The regular program was as follows:

C. W. STILES, Public Health Service: *Underground movements of bacteria.* The investigations on which this paper is based have been reported on in Public Health Reports **38**:1350–1353. 1923, from which the following abstract is derived:

The pollution of the ground-water (or phreatic water) by privy wastes, and the possibility and method of extension of this pollution to wells, springs, and other water supplies, have been subjects of discussion, experiment, and public health legislation for many years and in various parts of the world. In connection with investigations by the United States Public Health Service, extensive and rigorously controlled experiments have been made which bear upon the subject at issue and especially upon the movement of bacteria, of fecal origin, in the ground-water. These studies have involved the experimental pollution of the ground-water (namely, the water in the saturated zone, which supplies wells and springs), and have been correlated with the rise and fall of the ground-water table, the flow of ground-water, and the rainfall. *Bacillus coli* was taken as the bacterial test, and a dye (uranin) was utilized in tracing the movement of the water from the dosing trenches to the more than 400 experimental pipe wells which were arranged at intervals from the trenches and at various depths into ground-water.

The examination of thousands of water samples from the wells during a period of more than a year has resulted in very definite data which seem to express practically a natural law as applied to the movement of the bacteria in the field of fine sand in which the experiments were conducted. The results to date may be summarized as follows:

1. Pollution with fecal *Bacillus coli* has up to date been definitely and progressively followed in the ground-water for distances of 3 to 65 feet from the trench in which the pollution was placed; uranin has been recovered from these same wells and has spread to other wells at 70 to 117 feet from the

pollution trench. The soil in question is a fine sand with an effective size of 0.13 mm. 2. The pollution has traveled these distances within a period of 187 days, and only in the direction of the flow of the ground-water. 3. The pollution has traveled only in a thin sheet at the surface of the zone of saturation. 4. As the ground-water level falls, owing to dry weather, the pollution tends to remain in the sand above the new (lower) ground-water level, namely, in the new capillary fringe. 5. There is no evidence which would justify a conclusion at present that either the bacteria or the uranin is carried or moves to any appreciable distance in the capillary fringe itself. All present evidence is to the effect that when the ground-water level falls the pollution remains practically stranded in the capillary fringe or in the intermediate belt, according to the degree of fall of the ground-water. 6. A rainfall of 1 inch results in a rise of 5 to 6 inches in the ground-water table (in the particular experimental area in question); and if this rise is sufficient to reestablish the zone of saturation up at the level of the stranded pollution, the bacteria and the uranin are again picked up and carried along farther in the direction of the ground-water flow until dry weather again intervenes to cause another fall of the ground-water level. 7. Thus the progressive (passive) movement and the stasis (stranding) of the pollution are intimately connected with, are dependent upon, and alternate with the rise and the fall of the ground-water level, and this latter factor is dependent upon the alternation of wet weather and dry weather. 8. In explaining these results, capillarity, filtration, and gravity seem to come up for special consideration. 9. The ultimate distance to which the pollution will be carried is dependent upon a number of complex and interlocking factors, namely, wet and dry weather, with resulting rise and fall of the ground-water; the length of each of these periods; the rate of the ground-water flow (depending upon the "head," which, in turn, is dependent upon the rainfall); and, obviously, also the factor of the viability of the organisms under conditions of moisture, pH, food supply, etc. 10. The bearing of the foregoing results upon the intermittent pollution of wells, the location of water supplies, and the location of camps in peace or in war, will be evident to persons who are called upon for technical advice in these matters. 11. In protecting wells special attention should be given not only to surface protection as is now generally recognized but also to a new element, namely, the danger zone which exists from the highest water level to about a foot below the lowest water level. A leak in the pipe in this region is potentially very dangerous, and all wells unprotected in this danger zone are to be considered as potentially unsafe.

This paper was discussed by Messrs. Bond, Goldman, and Bailey.

Frank Bond, General Land Office: *Reproduction in painting of the metallic feathers of birds, with exhibition of paintings of hummingbirds.*

About fourteen years ago the speaker saw in the possession of W. L. Baily, of Ardmore, Pennsylvania, a book containing paintings of hummingbirds made by Mr. Baily's uncle fifty or sixty years before. The effort of this painter to reproduce in pictures the iridescence of the throat feathers of hummingbirds aroused the interest of the speaker, and urged him to make experiments with a view to reviving what was believed to be a lost art. After many months' effort he succeeded in painting pictures in which the luster of the feathers was brilliantly reproduced, as follows:

By means of a process which usually employs gold or silver leaf in order to secure a brilliant reflecting surface, which is the necessary first step, thereafter followed with successive applications on the reflecting surface of

a protecting transparent medium, a transparent paste colored with such transparent or lantern slide colors as many be required, and thereafter tracing with transparent or opaque colors feather designs to reproduce characteristic plumage details with the luster desired, he has succeeded in representing with remarkable fidelity the sheen of the hummingbird's plumage.

The collection of paintings exhibited by Mr. Bond represented the male of every United States species of hummingbird, except one, and of that no adult male has yet been collected.

In discussing the paper Dr. T. S. PALMER mentioned that the Mr. Baily, by whom the earlier paintings were made, had been in correspondence with John Gould, the celebrated British ornithologist, at the time of publication of Gould's monograph on the Trochilidae, and had in fact offered to communicate to Gould his secrets of painting,—an offer which was not accepted by Gould. The process invented by Mr. Bond has been patented, and may prove to be of commercial importance. (*Author's abstract.*)

658TH MEETING

The 658th regular and 44th annual meeting of the Biological Society was held at the Cosmos Club December 8, 1923 at 8:15 p.m., with Vice-President E. A. Goldman in the chair and 16 persons present. The minutes of the previous annual meeting were read and approved.

The reports of the Recording Secretary, the Corresponding Secretary, the Committee on Publications, and the Treasurer were read and accepted.

The following officers were elected: President, J. W. Gidley; Vice-Presidents, S. A. Rohwer, H. C. Oberholser, E. A. Goldman, A. Wetmore; Recording Secretary, S. F. Blake; Corresponding Secretary, T. E. Snyder; Treasurer, F. C. Lincoln; Members of the Council, C. E. Chambliss, H. C. Fuller, H. H. T. Jackson, W. R. Maxon, C. W. Stiles.

S. F. BLAKE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The sixteenth annual meeting of the American Institute of Chemical Engineers was held in Washington December 5–7, 1923.

At the meeting of the Petrologists' Club on Tuesday, December 4, 1923, the program was given by E. B. SAMPSON, who spoke on *Determination of anisotropy in metallic minerals,* and E. V. SHANNON, on *Mineralogy and petrography of intrusive Triassic diabase at Goose Creek, Virginia.*

Dr. ARTHUR L. DAY, director of the Geophysical Laboratory, Carnegie Institution of Washington, gave the inaugural lecture of the 1923 series before the members of the Royal Canadian Institute in Toronto, November 17. His subject was *Earthquakes and volcanic eruptions.*

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 FEBRUARY 4, 1924 No. 3

PHOTOGRAPHY.—*Stereoscopic photography in geological field work.*
F. E. WRIGHT, Geophysical Laboratory, Carnegie Institution of Washington.

Photography has rendered valuable services to geology both by providing illustrations for geological literature and, to a much greater extent, by furnishing note-book reminders of geological field relations which were difficult to describe concisely. The geologist on his return home from the field is aided by the snapshots he has taken to revisualize the field relations and thus to interpret the recorded data. The photographs are valuable to him in the degree they contribute to the revisualization process. If a print is large and the view is well chosen with regard to a proper foreground, so that the perspective relations are emphasized and even overemphasized, the observer gathers at first glance the impression of space and of the relative positions of the several details in the picture. If, on the other hand, the print is small with but little contrast in light and shade to bring out the perspective, the picture fails to convey to the eye an adequate impression of space. It is "flat," and is unsatisfactory both pictorially and for purposes of study. In some instances these defects can be remedied by making an enlarged print on contrast paper or by examining a small print on contrast paper through a magnifying glass.

Photography to the geologist is simply a means to an end, namely, to record certain spacial relations between details of geological interest in the field. He is not concerned primarily with the making of a photograph of artistic merit. His photograph should tell clearly the story of the field relations between certain geological features and everything must be subordinated to this story, otherwise the point may be lost. This means that the two factors, sharpness of detail and perspective

are essential; if, at the same time, a balanced rendering of the subject is possible, so much the better, but in no case should the correct rendering of geological details be sacrificed to gain pictorial quality. Another factor, that of scale, is also essential. Not only should the relative positions, but also the relative sizes of the details be represented by the photograph. In the case of near objects, such as rock exposures in a quarry or a cliff, a scale of known dimensions, as a geological hammer, or a hat, may be purposely introduced into the picture; for larger objects the figure of a man, looking toward the geological object and not toward the camera, may serve as a suitable scale. For objects at a distance, as a mountain side, a foreground is necessary not only to give the impression of distance, but also to convey an idea of the size of the mountain. A view taken from an elevated position, looking out over a wide plain or a valley is always disappointing because it fails to furnish a scale by which to measure distances and does not convey the impression of limitless expanse, which the observer on the mountain peak felt while taking the photograph.

Sharpness of detail in depth is attained by means of a small lens aperture. Color values are rendered so that they agree fairly well with the visual impressions by the use of color sensitive plates or films and properly adjusted ray filters. Perspective is attained chiefly by means of the foreground which, if skilfully selected, leads the eye from near objects to the more distant objects of geological interest and thus creates the impression of space and perspective. It is a simple matter to test this conclusion by first covering the foreground in a good photograph of distant mountains or hills and then observing the increase in apparent distance and perspective as the foreground is uncovered.

In the field the geologist is more or less encumbered with field apparatus and necessarily adopts the simplest camera that will answer the purpose. This is commonly a roll film camera of postcard size and equipped with a lens of focal length about 7 inches. Photographs taken with a lens of this focal length appear more natural and the depth relations stand out more clearly if they are examined through a reading glass. The effect of the reading glass is not only to magnify the print from one and one-half to twofold, but also to shift the image to a position more nearly in accord with that obtaining in the field where the objects were viewed directly. The combination of these two factors produces the enhanced stereoscopic effect or perspective obtained by use of the reading glass.

In case the geologist is in a position to carry a greater load, a larger camera, 5 by 7, or even larger, with a series of lenses or lens combinations covering a wide range in focal lengths enables him to obtain results not possible with the small hand camera. Even with the postcard size camera a small tripod well repays the extra trouble it may cause. By using a small lens aperture and a suitable ray filter, and by making a short time exposure with the camera mounted on a tripod, the geologist is more certain of uniformly good results than he can be with ordinary snapshots. Experience has shown that in the photography of geological subjects ample exposure (even slight over exposure) of the film and the use of adequate amounts of restrainer (potassium bromide) in the developer produces the best average results.

It is evident from the foregoing that geological photographs are essentially technical in character rather than pictorial; that the criteria for excellence in a geological photograph, are degree of sharpness, perspective, and scale; in other words, degree of exactness of representation of the field relations. If in addition pictorial quality is present in the photograph it may well serve for illustration purposes; pictures which tell a geological story and at the same time have artistic merit are rare. The geologist who introduces into his photographs as much of the pictorial element as the circumstances permit, but with due regard to accuracy in representation, is rewarded by genuine appreciation of his efforts. This would be lacking were the pictorial element lacking.

The feeling of space or stereoscopic effect in a photograph depends on the emphasis given to the perspective, and this is in part attained by means of a proper foreground with strong contrasts; but in the field a foreground of this character may not be available, and the resulting photograph is flat and represents inadequately the spacial relations. At best the stereoscopic effect in a photograph lags greatly behind the picture in the field, and there seems to be no remedy for this unless the geologist is willing to take two photographs of the object from slightly different positions and view the prints through a stereoscope Adequate representation is attainable only by means of stereoscopic photographs which enable the geologist at home to study the field relations in detail with a degree of certainty not attainable in the single view photograph. The taking of the two photographs requires no new apparatus; the two photographs are made with the same camera, one after the othe., at points separated by a distance dependent on the distance to the object to be photographed. It is surprising, in view of the ease with

which stereoscopic photographs can be taken with the ordinary hand camera and without a tripod, that this method is not in general use among geologists. This disregard of the stereoscopic method may be due to two factors, namely; the idea that a special stereoscopic camera is required; and the development of stereogrammetric methods for

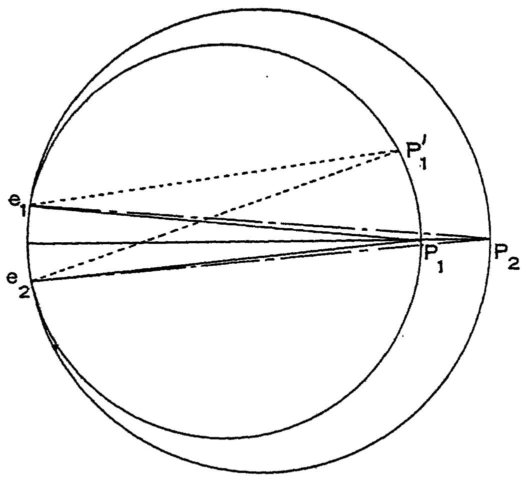


Fig. 1. Diagram to illustrate the principle of stereoscopic resolving power in depth.

field surveying which require special apparatus and are not adapted to ordinary geological field work. The purpose of this note is to emphasize the value of stereoscopic photographs in geological field work and to indicate briefly certain practical details in connection with the taking of stereoscopic views with an ordinary film camera.

Stereoscopic vision. Our ability to recognize the relative distances to two points P_1 and P_2 (Fig. 1) depends on the sensitivity of the eyes to slight angular changes between the lines of sight of the two eyes and to a much less degree on the change in focus of each eye as the line of sight passes from P_1 to P_2. In Fig. 1 let e_1, e_2 represent the two eyes; P_1 and P_2, two object points located at distances D_1 and D_2 respectively from the eyes. The angle between the lines of sight to P_1 is $e_1P_1e_2$, and to P_2, $e_1P_2e_2$. The difference between the angles $e_1P_1e_2$ and $e_1P_2e_2$

is the angular shift which takes place between the lines of sight to P_1 and P_2 respectively. It is evident from Fig. 1 that all points on the circle $e_1e_2P_1$ subtend at the eyes e_1, e_2 the same angle $e_1P_1e_2$; similarly all points on the circle $e_1e_2P_2$ subtend the angle $e_1P_2e_2$. If the interpupillary distance e_1e_2 be standard, namely 65 mm., the distance along the chord e_1e_2 is so nearly equal to that along the circumference for circles 1 meter and over in diameter that the difference (0.046 mm. or less) is for practical purposes negligible. On this assumption we derive directly from Fig. 1 for the points P_1 and P_2

$$\alpha_1 = \frac{e_1e_2}{D_1} = \frac{b}{D_1} \qquad \alpha_2 = \frac{e_1e_2}{D_2} = \frac{b}{D_1 + d}$$

wherein $b = e_1e_2$ and $D_2 = D_1 + d$. The angular difference in radians is accordingly

$$\alpha_1 - \alpha_2 = \frac{b}{D_1} - \frac{b}{D_1 + d} = \frac{b \cdot d}{D_1(D_1 + d)} = \frac{b \cdot d}{D_1^2\left(1 + \frac{d}{D_1}\right)}$$

As a rule d is a very small quantity compared with D_1 and the equation may be written as a first approximation

$$\Delta\alpha = \alpha_1 - \alpha_2 = \frac{b \cdot d}{D_1^2} \tag{1}$$

This equation indicates that for short distances to P_1 the change in angle for a given distance d is large; for greater distances to P_1 the change in angle is much less for the same interval d as is shown by Table 1 computed on the basis of an interpupillary distance $e_1e_2 = 65$ mm.

TABLE 1.—ANGLES SUBTENDED AT THE EYES (INTERPUPILLARY DISTANCE 65 MM.) BY THE LINES OF SIGHT TO AN OBJECT POINT AT A GIVEN DISTANCE IN METERS

DISTANCE TO P_1 IN METERS	ANGLE BETWEEN LINES OF SIGHT	DISTANCE TO P_1 IN METERS	ANGLE BETWEEN LINES OF SIGHT
0.25	14° 48.83′	20	0° 11.17′
0.50	7 26.28	30	0 7.45
0.75	4 57.75	40	0 5.58
1.00	3 43.38	50	0 4.47
2.00	1 51.72	100	0 2.23
3.00	1 14.48	200	0 1.11
4.00	0 55.86	300	0 0.74
5.00	0 44.69	400	0 0.56
10.00	0 22.34	500	0 0.45
		1000	0 0.22

Experiments by Helmholtz[1] and others on the ability of the eyes to distinguish the relative distances of objects from the observer have proved that on the average two points separated stereoscopically (in depth) by 30″ of arc and in exceptional cases by 10″ or 12″ or even less are recognized as situated in different planes. If therefore we assume a value

$$\Delta\,\alpha = \alpha_1 - \alpha_2 = 0.0001 \text{ in radians or } \Delta\,\alpha = 20.63''$$

equation (1) becomes

$$d = \frac{0.0001 \cdot D_1^2}{b}$$

Stereoscopic views. In the stereoscopic photography of geological features the combination of camera lens and plate functions as the eye. The distance between the two camera positions corresponds to the interpupillary distance and equation (1) is directly applicable, if the focal length of the camera lens is taken into account. The photographs thus taken are viewed with the aid of a stereoscope which may or may not be equipped with weakly magnifying lenses. The stereoscope is necessary because the eyes, as a result of long practice and habit, perform a series of operations automatically in passing from one object to another; at the same time that the object is brought to focus the lines of sight are adjusted for the distance. In the case of two photographs placed at the distance of near vision the eyes tend, in focussing on the photographs, to converge the lines of sight to a single point of a single photograph, whereas to see stereoscopically it is essential that the right eye focus on the right hand photograph, the left eye on the left. This it is possible to do with practice, but in general it is simpler and involves less eye strain to superimpose the two photographs by means of a stereoscope either of the reflecting mirror type (Wollaston or Helmholtz) or of the lens refracting type (Brewster or Helmholtz) in which the photographs are viewed through weak lenses so placed that the distances to the images appear to be comparable to those of the original object. In the case of a lens stereoscope the image is also enlarged and the stereoscopic effect is thereby enhanced.

[1] H. v. Helmholtz, Physiologische Optik 814 et seq. 1896; O. Hecker, Zeitschr. Instrumentenkunde **2**: 372. 1902; C. Pulfrich, Zeitschr. Instrumentenkunde **21**: 221. 1901; **22**: 65, 133, 178, 229. 1902; **23**: 43. 1903; **25**: 233. 1905; J. W. French, Trans. Opt. Soc. **24**: 226. 1923.

As a first approximation we may consider that the stereoscopic effect increases directly with the degree of enlargement of the photograph; and this in turn increases with the focal length of the camera lens and with the magnification by the stereoscope. Equation (1) may accordingly be written

$$\alpha_1 - \alpha_2 = \frac{d \cdot b}{D_1^2} \cdot \frac{f}{l} \cdot N \tag{2}$$

wherein f is the equivalent focal length of the camera lens, l the distance at which the photographs are viewed by the eye (commonly 10 inches or 25.0 cm., the distance of near vision), N the magnifying power of the stereoscope which, as ordinarily defined, is the ratio of the apparent height of the image observed through the lens at a distance l (10 inches) to the height of the object itself. Assuming the value, $\alpha_1 - \alpha_2 = 0.0001$, the magnifying power of the stereoscope to be $N = 2$, the distance of near vision $l = 10$ inches, we may write equation (2)

$$b = \frac{0.0001 \cdot 10}{2} \cdot \frac{D_1^2}{d \cdot f} = 0.0005 \cdot \frac{D_1^2}{d \cdot f} \tag{3}$$

Thus if a lens of focal length $f = 7$ inches, the separation b of the two camera positions required for a depth resolution of 1 per cent of the distance, $d = 0.01\ D$, is

$$b = \frac{0.0005 \cdot D_1}{0.01 \times 7} = 0.0071\ D_1$$

For $d = 0.001$, $b = 0.071\ D$; for $d = 0.005$, $b = 0.014\ D$. For a lens of focal length $f = 20$ inches we find for $d = 0.01\ D$, $b = 0.0025$; for $d = 0.001\ D$, $b = 0.025\ D$; for $d = 0.005\ D$, $b = 0.005\ D$. Similarly for an object at 2000 feet distance, the separation of camera positions with a lens of 12 inch focus required to enable the observer to recognize a depth difference of 2 feet ($d = 0.001\ D$) in the stereoscope is $b = \frac{0.0005 \cdot 2000^2}{2 \times 12} = 83.7$ feet.

In general it may be stated that, with ordinary cameras having lenses of focal lengths between 5 inches and 20 inches, a camera sepration of $\frac{1}{2}$ to 5 per cent of the distance suffices for critical stereoscopic studies; commonly a camera separation of 1 to 2 per cent of the distance to the object suffices. The greater the camera separation (up to 10 per cent) the higher the resolving power in depth. A separation b exceeding 10 per cent of D is likely to produce exaggerated perspective.

In the taking of stereoscopic views of geological features with a single camera the best results are obtained by holding the camera horizontal, by pointing it directly at the object, and by selecting, in a line approximately at right angles to the lines of sight, two positions from which the two views are taken, such that their distance apart is from ½ to 5 per cent of the distance to the object.

Experimental tests. In order to test the validity of equation (2) and incidentally to test the stereoscopic sensitivity of the eyes, a framework was constructed which consists essentially of a thick cardboard top

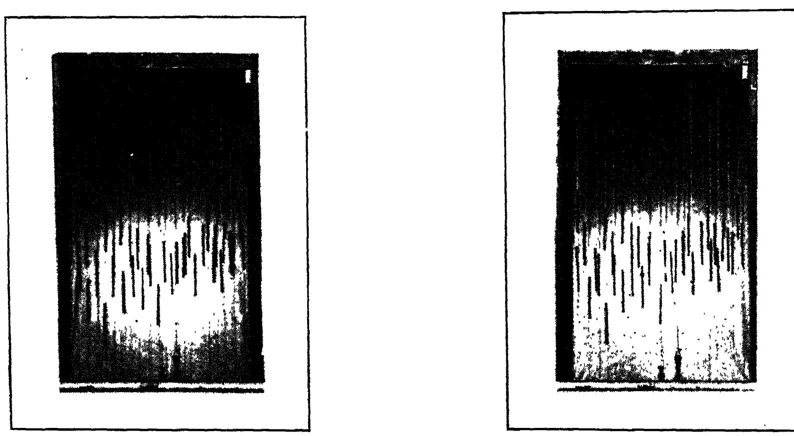


Fig. 2. Stereoscopic photographs of test objects taken at a distance of 20 meters with a camera lens of 22.7 inches focal length; the distance between the two camera stations was 40 cm.

and bottom each about 1 meter square, into which holes were drilled at different distances from the front edge. Through these holes cords were passed and through loops in the cords pencils were attached so that when mounted (Fig. 2) and viewed from a distance a number of vertical pencils appeared to be suspended in mid air against an illuminated back ground of white cloth tacked to the rear side of the framework. This group of suspended pencils was then photographed at a distance of 20 meters, with the camera at different distances of separation and with different lenses of focal lengths ranging from 7 inches to 69 inches. The minimum depth separation of the pencils was 4 cm. or 0.002 of the total distance. Prints of the photographs were then studied with the aid of a stereoscope equipped either with achromatic lenses of different focal lengths (E.F. = 80, 151, 190, and 241 mm.)

or with reflecting mirrors (Helmholtz arrangement). The separation of two adjacent lead pencils ranges from 4 cm. to 1 meter. As the observer passes from one part of the diagram to the other he records the relative positions in depth of the several pencils. The results which are listed in Table 2 are not very concordant. The degree of accuracy

TABLE 2.—THE DEPTH SEPARATION IN CENTIMETERS EASILY DETECTED STEREOSCOPICALLY, WITH THE AID OF A STEREOSCOPE OF MAGNIFYING POWERS RANGING FROM 1 TO 3.81, ON PHOTOGRAPHS TAKEN OF THE TEST OBJECTS (FIG. 2) AT 20 METERS DISTANCE AND WITH DIFFERENT CAMERA LENSES AND DISTANCES BETWEEN THE CAMERA POSITIONS

E.F. OF CAMERA LENS	DISTANCE BETWEEN CAMERA POSITIONS	MAGNIFICATION BY STEREOSCOPE			
		1	1.93	2.49	3.81
		Stereoscopic depth in cm. resolved on photographic prints			
cm.	*cm.*				
12.0	10	64	32	28	28
	20	48	24	20	16
	30		16	16	12
	40	24	12	12	12
	80	16	8	8	8
22.7	20	20	16	12	12
	40	16	12	8	8
	60	12	8	4	4
	80	8	4	4	4
68.7	10	20	16	16	12
	20	16	12	12	8
	30	8	8	8	4
	40	8	4	4	4

obtainable was found to be in part dependent on the quality of the photographic prints. The data were converted by means of equation (2) into angular values and these were then plotted on coordinate paper; the general trend of the values suffices to indicate that for the stereoscopic effect depicted in the photographs, the magnification factors introduced into the formula covering focal lengths of the camera lenses and magnifying power of the stereoscope are too large; in other words the stereoscopic effect under these conditions is increased with the magnification of the image but the degree of increase is appreciably less than that indicated by the formula. For the purposes for which the photographs are to be used, equation (2) may be considered, however, to represent the situation with sufficient accuracy. More detailed work would be required to determine the exact form of the equation with a given type of photographic print.

Summary. In geological field work stereoscopic photographs taken by the ordinary roll film camera are of value in assisting the geologist to

revisualize the relations studied in the field. Details which may have escaped his notice are brought out much more effectively than in the single photograph. The taking of stereoscopic photographs for this purpose does not require special apparatus. To obtain good stereoscopic effects it is advisable to take two photographs, one after another and from different positions, of the geological features to be recorded, the distance between the two camera stations to be from 1 to 5 per cent of the distance of the object itself, the camera in each position to be pointed at the object and the lines joining the camera stations to be approximately normal to the lines of sight to the object. The stereoscopic effect can be enhanced if enlarged prints of the negatives are made and a lens stereoscope of the ordinary type is used in the examination of the prints.

BOTANY.—*Two new species of* Jamesonia.[1] WILLIAM R. MAXON, National Museum.

Recent large collections of ferns from the Andes of South America have contained numerous specimens of *Jamesonia*, necessitating a revision of the genus. Of several species regarded as undoubtedly new two are described herewith.

Jamesonia brunnea Maxon, sp. nov.

Rhizome flexuose, wide-creeping, brown, terete, lignose, 3 to 4.5 mm. in diameter, densely clothed with oblique bright brown setae (2.5 to 3.5 mm. long). Fronds few, long-stalked, 55 to 70 cm. long, distichous, 7 or 8 mm. apart, erect-arcuate; stipes 25 to 30 cm. long, stout (1.5 to 2 mm. in diameter), subflexuose, brown, subangulate above, deciduously appressed-setose; blades linear, 25 to 30 cm. long, slightly attenuate toward the base, the rachis stout, brown, strongly compressed, lightly bisulcate above, everywhere densely and coarsely crispate-hirsute with broad flattish brown-ferruginous septate hairs, these never forming a tomentum; pinnae numerous, borne in two close rows on the upper side of the rachis, alternate, horizontal, usually arranged closely in a *single* scalariform series, stalked (1.5 to 2 mm.), broadly orbicular-ovate, rounded in the apical portion, truncate or very broadly cuneate at base, rigidly spongiose-coriaceous, strongly convex, broadly and deeply revolute, the slightly thinner margin freely ciliate (the cilia close, weak, flexuose, pale ferruginous, 1 mm. long); upper surface of pinnae strongly glandular-viscid, vernicose; lower surface glandular-pubescent and freely crispate-hirsute, chiefly along the veins, the shorter hairs erect and capitate, the long ones flexuose and septate like those of the rachis; larger pinnae 6 to 7 mm. long, 5 to 6 mm. broad; venation pinnate-flabellate, deeply immersed, barely evident above, coarsely corrugate beneath, 20 to 24 branches attaining the margin; sporangia not observed.

[1] Published by permission of the Secretary of the Smithsonian Institution.

Type in the U. S. National Herbarium, no. 1,067,752, collected at the summit of Mount Guamaní, Ecuador, altitude 4,000 meters, by Father L. Mille (no. 42).

In its large long-stipitate fronds and in its generally coarse aspect and habit of growth *Jamesonia brunnea* recalls *J. verticalis;* but the resemblance goes no farther, *J. verticalis* having, for example, adnate pinnae, in which it is unique. *J. brunnea* is more nearly related to *J. tolimensis* (Hieron.) C. Chr., of Colombia, which agrees in having the fronds long-stipitate and the pinnae truncate, ciliate, viscid-glandular above, and with a mixed glandular and septate-hairy covering beneath. *J. tolimensis* is, however, a smaller plant and has the pinnae chartaceous, sessile, roundish-obovate to obovate-elliptical, and the margins lobulate-crenate to crenulate, and short-ciliate (the cilia 0.5 mm. long or less), in all of which characters it differs from *J. brunnea.*

There is no other described species with which *J. brunnea* need be compared. The ladder-like arrangement of the alternate pinnae in a single or nearly single series at the upper side of the arcuate rachis is not due to pressure in drying, being quite as conspicuous in leaves that are restored to normal condition by boiling.

Jamesonia ceracea Maxon, sp. nov.

Rhizome wanting. Fronds (mature) 10 to 20 cm. long, nearly straight above the curved base; stipe 1 to 3 cm. long, 0.3 to 0.5 mm. in diameter, flexuose, strongly curved at summit, dark chestnut-brown, lustrous, minutely striate, deciduously and laxly setose, the hairs few, flattish, pale ferruginous, septate; blades 9 to 17 cm. long, 2 to 3.5 mm. broad, narrowly linear, long-attenuate toward the apex, the tip also attenuate though indeterminate; rachis relatively stout, castaneous, wholly concealed beneath by a dense imbricate covering of spreading or recurved, buff or pale ferruginous, flat, septate hairs, these concealing only the bases of the pinnae, persistent; pinnae 75 to 115 pairs, short-petiolate (about 0.5 mm.), alternate, mostly imbricate and horizontally deflexed in two contiguous rows upon the upper side of the rachis, those of the lower part spreading, more than their width apart, the lowermost ones distant; largest (middle) pinnae about 2.5 mm. long, 1.8 mm. broad, obliquely and broadly oblong from a subcordate inequilateral base, rigidly herbaceo-coriaceous, strongly convex, the deeply recurved margin nearly 0.5 mm. broad, crenately constricted, bordered abruptly by a broad whitish membranous true indusium, the aperture between the indusia 0.5 mm. broad or less; upper surface of pinnae grayish green, nearly glabrous, bearing a few minute short appressed whitish glandlike hairs; lower surface densely and deeply covered by minute white ceriferous hairs, the loose ceraceous mass mostly concealed by the revolute margins and broad indusia, persistent; venation pinnate-flabellate, deeply impressed, the branches 5 or 6 in number; sporangia not detected.

Type in the U. S. National Herbarium, no. 1,042,371, collected on steep páramo slope of Mount Chuscal, west of Zipaquira, Department of Cundi-

namarca, Colombia, altitude 3,100 to 3,200 meters, October 22, 1917, by Francis W. Pennell (no. 2607).

In size and general appearance *Jamesonia ceracea* is not very unlike small forms of *J. imbricata* (Cav.) Hook. & Grev., which it resembles also in having a relatively broad true indusium. It differs widely from that species in nearly all minute characters, however, and is the only member of the genus with ceraceous pinnae. The waxy indument of the under surfaces is not due to a juvenile condition or to extreme age, but is a definite morphological character. The loose waxy mass, which is persistent and is evident at all ages, is not quite amorphous, the presence of short, white, intermingled secreting hairs being readily demonstrable.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE BOTANICAL SOCIETY

167TH MEETING

The 167th meeting of the Botanical Society was held at the Cosmos Club April 3, 1923 with President L. C. Corbett in the chair and 32 persons present. N. REX HUNT was elected to membership in the society.

Program: F. V. COVILLE: *Experiments in Rhododendron culture.* (Illustrated). It has been recognized for some time that when rhododendrons have been taken from their natural habitat and planted around houses they frequently stagnate and die. This condition is caused by the change from an acid to an alkaline soil. Nurserymen claimed that rhododendrons could thrive in an ordinary fertile soil through the application of magnesium sulfate. It was decided to try magnesium sulfate and aluminum sulfate, also, in an experiment to bring about an acid reaction in an alkaline soil. A solution of magnesium sulfate stimulated the growth of seedlings of *Rhododendron catawbiense* to a slight degree, while a solution of aluminum sulfate very greatly stimulated the growth of the plants. A full discussion of *The effects of aluminum sulfate on Rhododendron seedlings* is presented in a paper by Dr. Coville, published as Bulletin 1 of the American Horticulture Society.

RUDOLF KURAZ, Secretary of the Czechoslovak Legation: *Seed control in Czechoslovakia.* The growing of cereals and industrial plants for seed is a well established industry in Czechoslovakia. For the protection of the growers as well as the purchasers a seed control law was passed by the National Assembly on March 17, 1921, supplementary regulations going into effect June 15, 1921. The law provides for official inspection, analysis, certification, and registration of original varieties developed by the growers and of seeds grown for them. Only those growers who have complied with the requirements of the law may use the designations "original variety," "certified seed," "certified seedlings," and "registered variety." The Ministry of Agriculture, charged with enforcement of the law, appoints certifying commissions for the various districts, as well as the Central Certifying Commission, an advisory body with offices at Prague. The analysis of seeds and the control of the trade in seeds have been intrusted to four

testing stations, or research institutes. A certifying commission has at least eight members and eight alternates, selected from among the expert officials of agricultural associations, instructors in agricultural colleges and other schools, and professional seed growers. Membership on the commission is purely honorary; the members receive no salaries and are compensated only for their actual expenses.

A. S. HITCHCOCK: *The proposed tropical biological station in the Panama Canal Zone.*

The Institute for Research in Tropical America, consisting of 5 museums, 6 universities, and 10 scientific societies, was organized in 1922 for the purpose of promoting research in tropical America. The Executive Committee decided to give prominence to research in Panama, because of the unusual biological conditions found here. The Isthmus is a bridge across which nearly all the migrations of land animals have taken place, and two great oceans are closer together here than in any other tropical region. Moreover, the physical conditions on the two sides of the Isthmus are distinctly different, and there is a corresponding difference in the marine faunas. The Atlantic side is uniformly hot; the Pacific side is cooler because of the cold currents from the north and south. Into these conditions has been thrown a disturbing factor—the Panama Canal. What effect will this have on the biological conditions?

The Institute will proceed with its program as soon as financial support is obtained. It is hoped to utilize the laboratories of the institutions already established in Panama, and to coöperate with all agencies interested in developing the resources of that region.

R. KENT BEATTIE, *Recording Secretary Pro Tem.*

168TH MEETING

The 168th meeting was held at the Cosmos Club May 1, 1923, with President L. C. Corbett in the chair and 65 persons present. H. C. DIEHL, F. P. SCHLATTER, JAMES H. BEATTIE, and F. L. GOLL were elected members of the society.

Brief notes: F. P. METCALF outlined his prospective work in China as head of the Botany Department at the Fukien Christian University. This school has financial support from the Chinese Government.

C. R. BALL spoke of the presence in the city of the representatives of foreign mission fields as guests of the Department of Agriculture.

Program: W. J. MORSE: *The soybean, abroad and at home.* (Illustrated.) The rapid rise of the soybean, also called soya and soja bean, to a crop of special importance in the world's commerce in the past few years is one of the important commercial events of recent times. It is a plant of ancient cultivation in China, Japan, and Chosen (Korea). The annals of Old China state that the soybean was an important food with the Chinese fully 5,000 years ago. When the ports of China were first opened to foreign commerce, the trade in beans and bean-products was found a long established and flourishing institution. In extent of uses and value the soybean is, at the present time, the most important legume grown in Asiatic countries. In addition to its use as food in the Orient, large quantities are utilized by first extracting the oil and then using the cake for stock feed and as a fertilizer.

At the close of the eighteenth century the soybean found its way to Europe, its cultivation being recorded in England in 1790. It is mentioned in the

United States as early as 1804. For several decades, however, it was regarded more as a botanical curiosity than as a plant of much economic importance. In 1875 Professor Haberlandt began an extensive series of experiments in Austria with the soybean, strongly urging its use as a food, both for man and beast. Although considerable interest was aroused during the experiments, the soybean failed to attain the success hoped by the author of the experiments.

Previous to the Russian-Japanese war, China and Japan were not only the greatest producers but also the greatest consumers of the soybean and its products. During the war the production of the crop was greatly increased throughout Manchuria. After the war, however, it became necessary to find new markets for the surplus beans and trial shipments were made to Europe. The first attempts to introduce the soybean and its products into European markets were generally unsuccessful owing to the inferior quality of the beans and cake, caused by poor shipping conditions. About 1908 a large trial shipment made to English oil mills was received in much better condition than the previous shipments, and the results obtained were so satisfactory that larger imports were made.

The success in the utilization of the soybean as an oil seed extended rapidly to the continental countries, and the importation of beans from Manchuria and Japan soon reached enormous proportions. The beans were utilized by extracting the oil that was found valuable for various industrial purposes, leaving the cake as a cattle food. As the value of the oil and cake came to be recognized, new uses and markets were found, and the trade assumed such large proportions that the soybean has become an important competitor of other oil seeds.

As previously stated, the soybean was introduced as early as 1804, but it is only within recent years that it has become a crop of much importance in the United States. The soybean, until the present season, has been grown primarily as a forage crop. The increased demand for seed, for food, and for planting has led to the development of a very profitable industry in many sections of the cotton and corn belts. The large yield of seed, the ease of growing and handling the crop, the value of the beans for both human and animal food, and the value of the oil and meal, all tend to give this crop a high potential importance and assure its greater agricultural development in America.

C. A. Reed: *Glimpses of economic trees and plants of China.* (Illustrated.) So great is the need due to the density of its population and so limited the means of distribution of its products that it would not be far wrong to put all plants of North China into one group, namely, an economic group. In such provinces as Shantung, where the population is in the neighborhood of 600 to the square mile, practically everything is economized with the exception of labor. Every part of the cultivated plants is utilized in one or more ways. China is commonly regarded as being a treeless country, yet the city streets and their various compounds are adorned with such species as whaishu, (*Sophora japonica*), German acacias, willows, catalpas, poplars, ginkgos, jujubes, persimmons, pines of various species, cedars, arbor vitae, pistache, and even oaks, and other genera more or less familiar in this country. Not infrequently, large areas of house tops are hidden from view by foliage in the cities and towns. All brush of the mountains is used either in the manufacture of wicker-ware or for fuel, or other purposes. The sour fruits of the low-growing jujube are gathered for food, and the spiny

branches used for obstructions either as simple fences or barricades on the tops of walls. For fuel, all lower branches of non-fruit producing trees are cut, and the trunks of trees having scaly bark are pared as closely as possible without serious injury. Field crops, such as corn, sorghum, soybeans, millet, etc., are either pulled up by the roots at harvest time or cut in the usual way, and later the roots are taken up and used for fuel. Apparently the soybean nodules on the roots are mainly responsible for the fertility of the soil.

Planted trees along railroad lines, about family cemeteries, or elsewhere in the landscape form some of the most familiar sights throughout the plains sections of Northeast China. Perhaps the most graceful in appearance are the various species of willow. The basket willow, with its side branches removed well up to near the tops of the trees, bears striking resemblance to the American elm. Probably the most highly prized species of tree is that of the white-barked pine, *Pinus bungeana*, which, when dormant, greatly resembles the American sycamore and the Oriental plane. This species is claimed to be exceedingly difficult to propagate and of slow growth, yet exceedingly longlived. For these reasons it was a great favorite with the royalty of at least one dynasty, the Ming. Wherever members of that family established themselves, avenues of these trees were sure to be planted. Single specimen trees and occasional avenues still remain, and in one case a forest of several acres extent is still to be seen, although from 300 to 500 years have elapsed since they were planted, and in spite of the fact that the succeeding dynasty, the Manchu, apparently sought literally to uproot the trees as well as, figuratively, to uproot everything else pertaining to the Ming.

Among fruit-producing trees North China has a great range of species and varieties. Of these, in probable order of excellence, there are the persimmon, pear, jujube, or chinese date, as it is called, and the hawthorne. Of chestnuts there is an equally choice range of strains. The same might be true of walnuts if the product were to be allowed to properly ripen before being harvested. The native apples are of low order; they could doubtless be improved upon by crossing with the wild types of lower New England; certainly this would make the quality no worse. Some of the peaches are very fine and can well. The Bartlett pear was introduced from America some 50 years ago by John L. Nevius, a Presbyterian missionary at Chefoo, who is also credited with having introduced many other American fruits. There is said to be a highly developed fruit industry on the north side of Shantung Peninsula in the neighborhood of Chefoo. Bartlett pears from that section were common on the hotel tables from Peking south to Shantung throughout what seemed to be a long season. The Concord grape appeared somewhat sparingly in an important fruit center, 100 miles to the northeast of Tientsin. However, European grapes lead American varieties in extent of planting, and in some sections they are of large importance. Other American products successfully established in China are the peanut, the sweet potato, and Indian corn. Most American vegetables and fruits have their counterparts in China. The total number of Chinese varieties surpasses that of this country, yet with the exception of paitsi, egg plant, carrots, and a few others, these varieties show little evidence of having been bred up and improved systematically. Walnuts and chestnuts are propagated by seedage only.

Roy G. Pierce, Recording Secretary.

SCIENTIFIC NOTES AND NEWS

PHILIP S. SMITH, of the Geological Survey, has returned to the Alaska Branch, and will undertake for that Branch and the Navy Department the examination of Naval Petroleum Reserve No. 4, Alaska. JULIAN D. SEARS has been designated Administrative Geologist to fill the position relinquished by Mr. Smith.

The 348th meeting of the Washington Section of the American Chemical Society, on December 13, 1923, was made a special meeting in honor of the seventieth birthday (on December 12) of Dr. W. F. HILLEBRAND, chief chemist of the Bureau of Standards. His long service in the development of analytical chemistry, especially of the silicates, was discussed by several speakers. Dr. Hillebrand presented a paper on *The importance of exact rock analysis for petrology.*

HENRY M. AMI has returned from France to Ottawa and resumed his work in paleontology and chronological geology. During the last six months, serving with the Canadian Government mission on Natural Resources to France, Dr. Ami has carried on researches in pre-history in the Dardagne and elsewhere.

H. A. C. JENISON has resigned from the Geological Survey to accept a position as mining engineer with the Senate Commission on Gold and Silver Inquiry.

A Washington-Baltimore section of the American Ceramic Society was organized December 14, 1923, at a meeting held at the Garden Tea House, Washington. Officers elected were: *Chairman,* B. T. SWEELY; *Vice-chairman,* R. R. DANIELSON; *Secretary-Treasurer,* HERBERT INSLEY; *Councillor,* KARL TURK. A paper on *Use of the petrographic microscope in the ceramic industry* was presented by Mr. Insley. Meetings of the section will be held alternately at Washington and Baltimore.

The Physics Club of the Bureau of Standards has had on its program a series of meetings dealing with *The phenomena and theories of sound.* The following two lectures of this series remain to be delivered: Feb. 4: III, E. A. ECKHARDT: *The characteristics essential to the faithful reproduction of physical phenomena (e. g. oscillographs, phonographs, loud speakers, etc.)* Feb. 11: IV, H. C. HAYES: *Safeguarding navigation by sound.*

The next series of meetings will be devoted to the electrical properties of materials. The following subjects are announced: Feb. 18: I, H. L. CURTIS: *The conduction through dielectrics.* Feb. 25: II, H. L. CURTIS: *Electric absorption and dielectric loss,* Mar. 3: III, F. B. SILSBEE: *Electric strength of insulating materials.* Mar. 10: IV, Subject not yet determined. Mar. 17: V, W. BLUM and H. S. RAWDON: *The mechanism of electro-deposition.*

These meetings extend from 4:30 to 5:30 each Monday afternoon and are open to all interested. The place of meeting is the Lecture Room, Chemistry Building, Bureau of Standards.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 14 February 19, 1924 No. 4

CHEMISTRY.—*The polymorphic forms and thermotropic properties, of Schiff's bases derived from 3-methoxy-4-hydroxy-5-iodo-benzaldehyde.*[1] Raymond M. Hann, Bureau of Chemistry, Department of Agriculture. (Communicated by Edgar T. Wherry).

The apparent tendency of Schiff's bases[2] to form isomeric compounds,[3] differing in color, solubility, and other physical properties, has encouraged an extensive study of this class of aldehydic derivatives. These compounds differ in their major physical properties, and some show marked changes in color when recrystallized from different solvents,[4] and even from the same solvent, under varying conditions of concentration and temperature.[5]

Senier and Forster[6] state that Schiff's bases containing a hydroxyl group para to the aldehyde amine linkage are of particular interest in that they yield dimorphic forms on trituration. Senier and Shepheard[7] showed that salicylidene metatoluidine, a hydroxy anil of the Schiff base type, exhibited phototropic properties when exposed to actinic light. A little later the same author[8] demonstrated that compounds of this type also showed reversible changes in color upon

[1] Presented at the Milwaukee meeting of the American Chemical Society, September 10–14, 1923.

[2] These bases result from the equimolecular condensation of an aldehyde and a primary amine. Dimroth and Zölppritz, Ber. **35**: 984. 1902.

[3] Senier and Shepheard, Journ. Chem. Soc. **95**: 1944. 1909.

[4] Morgan and Jones, Journ. Soc. Chem. Ind. **42**: 92T. 1923.

[5] Senier, Shepheard, and Clarke, Journ. Chem. Soc. **101**: 1950. 1912.

[6] Senier and Forster, Journ. Chem. Soc. **105**: 2462. 1914.

[7] Senier and Shepheard, Journ. Chem. Soc. **95**: 441. 1909.

[8] Senier and Shepheard, Journ. Chem. Soc. **95**: 1943. 1909.

heating, a characteristic which they called thermotrophy. These authors advanced the opinion that phototropic and thermotropic changes are due to isomeric changes affecting the aggregation of molecules rather than to any intramolecular change. In an effort to obtain more definite information upon these phenomena, Senier and various co-workers have prepared and studied characteristic ortho-hydroxy α-naphthylidene,[8] salicylidene,[7] ortho-nitro benzylidene,[9] para-hydroxy benzylidene,[10] vanillidene,[11] and anisylidene[12] aryl amines. No definite relationship between the optical phenomena observed and the constitution of the compounds could be traced. It was noted, however, that the para-hydroxy benzylidene compounds were not phototropic.

The series of compounds here discussed was prepared in order to study the possible effect of the addition of a negative radical to a para-hydroxy benzaldehydic aryl amine on the phototropy and thermotropy. The aldehyde chosen for this purpose was 3-methoxy-4-hydroxy-5-iodo benzaldehyde which was readily prepared from vanillin (meta-methoxy para-hydroxy benzaldehyde) by a modification of the method of Carles.[13] It is evident that his original preparation was not pure since he reports 174°C. as the melting point of the halogen substituted aldehyde, while the pure compound melts at 180°C. Bougault and Robin have prepared the substance by an indirect method (the interaction of benzenyl-iodo-amidine and vanillin), and the melting point reported[14] is identical with that obtained during the present study.

The mechanism[15] of the condensation between equimolecular proportions of an aromatic aldehyde and an amine is now well understood. The reaction proceeds in two stages, the first resulting in the formation of an intermediate addition product (1) which generally splits off water to give the condensation product (2) which it is not unreasonable to suppose could also exist in a stereoisomeric form (3).[16]

[9] Senier and Clarke, Journ. Chem. Soc. **105**: 1917. 1914.

[10] Senier and Forster, Journ. Chem. Soc. **105**: 2462. 1914.

[11] Senier and Forster, Journ. Chem. Soc. **107**: 452. 1915.

[12] Senier and Forster, Journ. Chem. Soc. **107**: 1165. 1915.

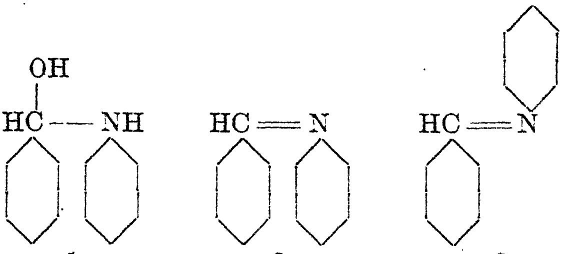
[13] Carles, Bull. Soc. Chim. Paris **17**: 14. 1872.

[14] Bougault and Robin, Compt. rend. **172**: 452. 1921.

[15] Lowy, *et al.*, Journ. Am. Chem. Soc. **42**: 849. 1920; **43**: 346. 1921. Noyes, Journ. Am. Chem. Soc. **44**: 2558. 1922. Dimroth and Zölppritz, *loc. cit.*

[16] Lowy and King, Journ. Am. Chem. Soc. **43**: 625. 1921.

Compounds of Type 1 are obtained only rarely, although Rugheimer,[17] who obtained a series from chloral and various amines, shows that increased basicity tends toward increased stability. A summary of such derivatives is included in a paper by Raiziss and Blatt[18] who obtained addition compounds from arsephenamine and



1 2 3

aromatic aldehydes. The fact that Downey and Lowy[19] were able to form a compound of this general constitution from 2, 4-dinitrobenzaldehyde and ortho-toluidine led to an attempt to prepare a similar compound from 3-methoxy-4-hydroxy-5-iodo benzaldehyde. The desired combination was not effected, however, under the present experimental conditions.

Compounds of Type 2 and aniline, o-chloro aniline, p-chloro aniline, p-iodo aniline, p-bromo aniline, o-toluidine, m-toluidine, p-toluidine, ψ-cumidine, p-amino phenol, m-amino phenol, α-naphthylamine, β-naphthylamine and benzidine were readily obtained from 3-methoxy-4-hydroxy-5-iodo-benzaldehyde. The following amines did not react under the experimental conditions employed: 2,4 dichloro aniline, the three nitranilines, tri-bromo aniline, o-bromo aniline, and tri-nitro aniline.

With one or two exceptions the substances obtained are remarkably resistant to the action of actinic light. None of them are phototropic. Most of them show no marked thermotropic change upon exposure to heat. Since the vanillidene aryl amines studied by Senier did show marked changes upon heating, it is evident that the addition of iodine causes some fundamental change in the ability of the derivatives to undergo thermotropic transformation.

[17] Rugheimer, Ber. **39:** 1653. 1906.

[18] Raiziss and Blatt, Journ. Am. Chem. Soc. **44:** 2023. 1922.

[19] Downey and Lowy, Journ. Am. Chem. Soc. **45:** 1060. 1923.

No sign of a structurally isomeric compound (Type 3) was obtained. Brady and Dunn[20] were unable to prepare the two stereoisomeric oximes of the 5-nitro and 5-bromo meta-methoxy para-hydroxy benzaldehydes and it is possible that the occupation of the 5-position has a marked effect upon the formation of stereoisomeric forms.

EXPERIMENTAL

5-Iodo-vanillidene aniline.—Warm alcoholic solutions (100 cc.) of equivalent weights of aniline and iodo vanillin were mixed, heated for 15 minutes, concentrated to a volume of 50 cc., filtered, and allowed to cool slowly to room temperature. The condensation product separated in rosettes of beautiful iridescent needlelike crystals. Recrystallized from ethyl alcohol the substance was obtained as flattened bipyramidal crystals of a brilliant deep red color. Upon removal from solution the crystal faces rapidly lost their brilliant luster and in a period of three weeks had become completely opaque and had assumed a yellow color. When crushed the red crystals yielded an orange powder which melted to a dark red oil at 152–153°C. The substance was soluble in methyl and ethyl alcohols, acetone, and chloroform, and was apparently decomposed by boiling water. The compound was neither phototropic nor thermotropic.

Analysis: 0.1004 gram of substance consumed 2.8 cc. $\frac{N}{10}$ acid (Kjeldahl)[21] 3.91 per cent N. Theory for $C_{14}H_{12}O_2NI$ = 3.97 per cent.

HALOGEN ANILINES

5-Iodo-vanillidene o -chloro-aniline $C_6H_2\ \overset{3}{(OCH_3)}\ \overset{4}{(OH)}\ \overset{5}{(I)}\ CH = \underset{2}{N}C_6H_4\ (Cl)$.—The chloro aniline condensation products were prepared by adding 1.2 grams of the halogenated amine to an alcoholic solution containing 2 grams of aldehyde, concentrating to a volume of 10 cc., and cooling slowly. It was necessary to scratch the beaker vigorously to cause separation of the ortho chloro compound. Recrystallized from alcohol, the substance separated as a mass of yellow-brown crystals. These showed slight change on trituration, were not phototropic, and did not show a thermotropic change on heating. Heated in a capillary tube, the crushed crystals contracted at 138°C. and melted at 143°C. to a black tarlike mass.

[20] Brady and Dunn, Journ. Chem. Soc. 109: 667. 1916.

[21] For this and other nitrogen analyses reported in this paper the author is indebted to L. J. Jenkins of the Nitrogen Laboratory, Bureau of Chemistry.

Analysis: 0.2949 gram of substance consumed 7.1 cc. $\frac{N}{10}$ acid (Kjeldahl) 3.37 per cent N. Theory for $C_{14}H_{11}O_2NICl$ 3.62 per cent N.

5-Iodo-vanillidene p-chloro aniline $C_6H_2\ (\overset{3}{OCH_3})\ (\overset{4}{OH})\ (\overset{5}{I})\ CH = NC_6H_4\ (\overset{4}{Cl})$.—The para isomer separated from the alcoholic solution in brilliant red iridescent needles. Upon trituration an orange colored powder which was neither thermotropic nor phototropic was obtained. The anil melted with decomposition at 110–111°C.

Analysis: 0.1048 gram of substance consumed 2.7 cc. $\frac{N}{10}$ acid (Kjeldahl) 3.61 per cent N. Theory for $C_{14}H_{11}O_2N\,I\,Cl$ 3.62 per cent N.

5-Iodo-vanillidene p-bromo aniline $C_6H_2(OCH_3)(OH)(I)CH=NC_6H_4(Br)$.—The condensation product was obtained as a yellow-brown powder and was recrystallized from alcohol. Upon trituration, it assumed a yellow green color and a characteristic metallic luster. It melted with partial decomposition to a yellow brown liquid at 108°C.

Analysis: 0.1108 gram of substance consumed 2.6 cc. $\frac{N}{10}$ acid (Kjeldahl) 3.29 per cent N. Theory for $C_{14}H_{11}O_2N\,I\,Br$ 3.24 per cent N.

5-Iodo-vanillidene p-iodo aniline $C_6H_2(OCH_3)(OH)(I)CH=NC_6H_4(I)$.—This is similar to the corresponding bromo derivative, occurring as a yellow-brown powder, which upon trituration becomes yellow-green and shows the metallic luster exhibited by the bromo compound. It melts somewhat slowly at 98°C. to a clear light-brown liquid.

Analysis: 0.1417 gram of substance consumed 2.8 cc. $\frac{N}{10}$ acid (Kjeldahl) 2.77 per cent N. Theory for $C_{14}H_{11}O_2N\,I_2$ 2.92 per cent N.

Toluidines

5-Iodo-vanillidene o-toluidine $C_6H_2\ (\overset{3}{OCH_3})\ (\overset{4}{OH})\ (\overset{5}{I})\ CH = N\ C_6H_4\ (CH_3)$.—This condensation product was obtained by following the general directions given under the corresponding aniline compound. It was necessary to scratch the beaker vigorously to cause precipitation. Recrystallized from absolute alcohol, it was obtained as wart-like masses of light-yellow microcrystalline needles. Upon trituration a deep yellow polymorphic form was obtained. Upon heating in a capillary tube this form becomes deeper colored, but, since it fails to show a reverse color change upon cooling, it cannot be classed as thermotropic. Both forms of the substance melt at the same temperature (120-1°C.) to a dark-brown tarry mass. The substance is quite soluble in the usual organic solvents.

Analysis: 0.2130 gram of substance consumed 5.8 cc. $\frac{N}{10}$ acid (Kjeldahl) 3.81 per cent N. Theory for $C_{15}H_{14}O_2NI$ 3.82 per cent N.

5-Iodo-vanillidene m-toluidine $C_6H_2\overset{3}{(OCH_3)}\overset{4}{(OH)}\overset{5}{(I)}CH = NC_6H_4\overset{3}{(CH_3)}$.—Two grams of iodo vanillin and 1.5 grams of the pure amine were dissolved in 50 cc. of alcohol and the solution was boiled vigorously for 5 minutes, after which the solution was filtered and allowed to cool slowly to room temperature. Upon standing overnight the compound separated out in granular orange-red crystals. Upon trituration a darker red form is obtained, but neither form is thermotropic or phototropic. The substance is soluble in alcohol, acetone, and chloroform. It fuses to an opaque yellow liquid at 103–4°C. which, at 145°C., clears up to a deep red oil.

Analysis: 0.2008 gram of substance consumed 5.7 cc. $\frac{N}{10}$ acid (Kjeldahl) 3.98 per cent N. Theory for $C_{15}H_{14}O_2NI$ 3.82 per cent N.

5-Iodo-vanillidene p-toluidine $C_6H_2\overset{3}{(OCH_3)}\overset{4}{(OH)}\overset{5}{(I)}CH = NC_6H_4\overset{4}{(CH_3)}$.—This anil was prepared in the same manner as the isomeric compound. Boiling was necessary to complete the original solution. Upon standing overnight the anil had separated in clear brilliant golden-brown crystals. Upon vigorous trituration or heating this deep yellow form becomes nearly colorless and it does not return to its original color on cooling. Upon standing at room temperature, the deep yellow form slowly reverts to the paler form. Both varieties melt at 160–1°C.

Analysis: 0.2005 gram consumed 2.6 cc. $\frac{N}{5}$ acid (Kjeldahl) 3.63 per cent N. Theory for $C_{15}H_{14}O_2NI$ 3.82 per cent N.

Napthylamines

5-Iodo-vanillidene α-naphthylamine $C_6H_2\overset{3}{(OCH_3)}\overset{4}{(OH)}\overset{5}{(I)}CH = NC_{10}H_7$.—A great deal of difficulty was encountered in preparing this derivative. After repeatedly obtaining heavy dark-red oils, a very dark crystalline material was obtained from the supernatant liquids remaining after precipitation of the tarry mass. This was carefully recrystallized from alcohol from which it tended to separate as an oil but was finally obtained as a yellow brown crystalline deposit. When crushed it yielded a bright yellow powder, which became much lighter in color when heated in a capillary tube. It contracted at 150°C. and, on increasing the temperature, assumed a condition of a red melt which finally decomposed at 226°C.

Analysis: 0.1824 gram of substance consumed 4.5 cc. $\frac{N}{10}$ acid (Kjeldahl) 3.46 per cent N. Theory for $C_{18}H_{14}O_2N\,I$ = 3.47 per cent N.

5-Iodo-vanillidene β-napthylamine $C_6H_2 \overset{3}{(OCH_3)} \overset{4}{(OH)} \overset{5}{(I)} CH = NC_{10}H_7$.—An effort was made to obtain this compound in an isomeric form by working below 0°C., but the substance obtained at the lower temperature was identical with that prepared by the general procedure. The substance is obtained in clusters of light yellow microcrystalline needles upon recrystallization from alcohol. It is dimorphous, a deep yellow variety being produced on trituration. Exposed to the rays of actinic light, it rapidly darkens to a deep brown color but no reverse change was observed when the compound was placed in the dark over a protracted period. The anil melted at 163°C. to a clear red oil.

Analysis: 0.2738 gram of substance consumed 6.3 cc. $\frac{N}{10}$ acid 3.22 per cent N. Theory for $C_{18}H_{14}O_2N\,I$ =3.47 per cent N.

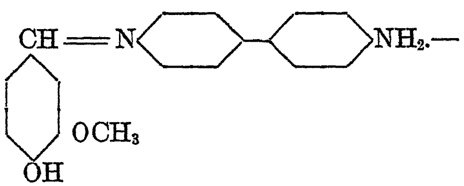
Cumidines

5-Iodo-vanillidene pseudo-cumidine $C_6H_2 \overset{3}{(OCH_3)} \overset{4}{(OH)} \overset{5}{(I)} CH = \overset{5}{N}C_6H_2 \overset{1}{(CH_3)} \overset{2}{(CH_3)} \overset{4}{CH_3}$.—This anil was obtained as a chocolate brown powder. Upon vigorous trituration it becomes yellow, the color change being well marked. The substance is soluble in the usual organic solvents and melts at 165°C. when slowly heated.

Analysis: 0.2457 gram of substance consumed 6.0 cc. $\frac{N}{10}$ acid (Kjeldahl) 3.42 per cent N. Theory for $C_{17}H_{18}O_2N\,I$ = 3.54 per cent N.

Di-amines

5-Iodo-vanillidene-benzidene



Equimolecular proportions of the aldehyde and amine were heated together for two hours in alcoholic solution, filtered, and rapidly cooled. The condensation product separated in bright orange flocks. Upon trituration it undergoes the most marked color change of any of these derivatives, assuming a bright crimson color, somewhat like,

though not exactly comparable with, that of mercuric iodide. The substance is slightly soluble in ether and benzene, soluble in ethyl and methyl alcohols, and very soluble in acetone and chloroform. It undergoes incipient decomposition when heated, melting to a deep red oil at 160–1°C.

Analysis: 0.2100 gram of substance consumed 9.4 cc. $\frac{N}{10}$ acid (Kjeldahl) 6.27 per cent N. Theory for $C_{20}H_{17}O_2N_2I$ = 6.30 per cent N.

SUMMARY

A number of derivatives of the Schiff base type have been prepared from 3-methoxy-4-hydroxy-5-iodo-benzaldehyde and aromatic amines.

The 5-iodo vanillidene aryl amines are not phototropic.

The addition of iodine to meta methoxy para hydroxy benzaldehyde apparently reduces its ability to yield thermotropic anils when condensed with amines.

Upon vigorous trituration the condensation products of the aldehyde and amines produce polymorphic forms, differing markedly in color

BOTANY.—*New or critical ferns from Haiti.*[1] WILLIAM R. MAXON, National Museum.

The present paper contains descriptions of four new species of Polypodiaceae from Haiti, as well as notes upon several other species that either are new to the Haitian flora or have other points of interest. Of the new species three are based upon material collected in the early part of 1920 by E. C. Leonard of the U. S. National Museum, while accompanying Dr. W. L. Abbott on an extended trip of biological exploration in Haiti. The other new species belongs to a critical group in the genus *Dryopteris*, and is founded on a specimen collected by W. Buch, this being one of a considerable number recently received from the Berlin Botanical Museum for identification. A complete enumeration of Mr. Leonard's large collection will be offered for publication later in the year; the new species only are published at the present time, in order that they may be available for citation by Dr. I. Urban, who is about to publish a systematic catalog of the pteriodophyta known from the island of Hispaniola.

[1] Published by permission of the Secretary of the Smithsonian Institution.

Adiantum cuneatum Langsd. & Fisch.

A single collection: Morne de Ouésanne, Furcy, altitude 1,300 meters, in shaded ravine, June 13, 1920, *Leonard* 4781.

Apparently indigenous. So far as the writer knows, this South American species has not previously been reported as native to the West Indies. It is cultivated the world over and in tropical regions is known to have sometimes escaped and become naturalized; for example, on banks in the vicinity of the botanical station at Cinchona, Jamaica, at 1,500 meters elevation.

Cheilanthes leonardi Maxon, sp. nov.

Rhizome multicipital, the divisions 1 to 3 cm. long, horizontal, densely paleaceous, the scales oblique, imbricate, rigid, subulate to linear-triangular and attenuate, 2 to 3 mm. long, up to 0.5 mm. broad at base, dark castaneous, greatly thickened throughout, entire. Fronds numerous, close, rigidly erect, mostly 20 to 30 cm. high; stipes 14 to 21 cm. long, 0.3 to 0.6 mm. thick, straight above the arcuate base, wiry, dull dark castaneous, naked; blades broadly ovate-deltoid, subpentagonal, 6 to 11 cm. long, 3.5 to 10 cm. broad at base, sub-bipinnate below, deeply pinnatifid at apex, both the apex and pinnae conspicuously long-caudate; rachis similar to stipe, but closely glandular-puberulous along the ventral groove; main pinnae 1 to 3 pairs, ascending, the basal ones the largest, these sessile, deltoid in outline, inequilateral, 2 to 6 cm. long, 1.5 to 4.5 cm. broad at base, nearly pinnate, with 1 to 5 pairs of segments (the proximal basal one longest), these distant, subopposite, oblique, narrowly linear, 2 mm. broad, arcuate, abruptly discontinuous, the apical segment greatly elongate, linear, up to 4 cm. long in large specimens; second pair of pinnae 1 to 2 cm. distant, adnate, elongate-triangular, strongly inequilateral, in small blades simple or with a single elongate proximal basal segment, in larger blades with 3 to 5 proximal and 1 to 3 distal segments, these all distant, linear, simple; third pair of pinnae simple or sometimes with 1 or 2 proximal basal segments; remaining pinnae simple, narrowly linear, oblique, decurrent, the apical ones joined by a rachis wing as broad as their own width, abruptly discontinuous, the long-caudate terminal segment up to 5.5 cm. long in large blades, 2 mm. broad at base; veins free, arcuate, once-forked, impressed above; segments subcoriaceous, evenly and obliquely crenate from the development of saccate recesses underneath the sharply revolute margin, a vein-branch terminating at each sinus; sori terminal (the receptacle transversely enlarged), the sporangia spreading laterally in a continuous line, partly concealed; indusium continuous, brown, firmly membranous, broad, often extending nearly to the strongly elevated costa, flat or (at maturity) arched or even reflexed to the plane of the blade, entire.

Type in the U. S. National Herbarium, no. 1,077,048, collected in the vicinity of Furcy, Haiti, altitude about 1,300 meters, from rocky bank of a ravine, June 5, 1920, by E. C. Leonard (no. 4552). Represented also by *Leonard* 4483 and 4498 from the same region, and by *Buch* 1946, the last a depauperate specimen from Morne de Brouet,[2] Haiti, in the Berlin Museum.

Cheilanthes leonardi belongs to the subgenus *Mildella,* and is the West Indian analogue of *C. intramarginalis* (Kaulf.) Hook., which ranges from Mexico to Bolivia. From that species it differs sufficiently in its slender

[2] According to Mr. Leonard this is the same mountain called by the natives "Morne de Ouésanne."

stipes, its short, ovate-deltoid (not lanceolate or oblong), long-caudate blades, its few and much simpler, conspicuously caudate pinnae, and its few, narrowly linear, invariably simple, distant pinnules.

Hypolepis hispaniolica Maxon, sp. nov.

Plants about 2 meters high, semierect; rhizome not collected; blades about 1.5 meters long, at least 1.2 meters broad, subquadripinnate; primary rachis 3 mm. thick, cinnamomeous, sparingly aculeate (the spines 0.5 to 1 mm. long, conical, pungent, spreading or retrorsely curved), with a loose deciduous covering of bright brown, flexuous, flattish, intestiniform hairs; primary pinnae oblique, sessile, triangular-oblong, acuminate, the largest ones 65 cm. long or more, about 35 cm. broad just above the base, the secondary rachis aculeate like the primary; secondary pinnae about 10 pairs below the acuminate apex, distant, spreading, antrorsely falcate, the distal basal one greatly reduced, the other distal ones somewhat shorter than the proximal ones, all narrowly triangular-oblong, acuminate, the largest 20 cm. long, 10 cm. broad, the tertiary rachis subflexuous, aculeolate; pinnules about 12 pairs, spreading, distant, alternate, the distal basal one greatly reduced or vestigial, the others fully developed, pinnate, oblong or deltoid-oblong from an inequilateral base, long-acuminate, the costa everywhere minutely aculeolate beneath, narrowly foliaceo-marginate; segments 7 or 8 pairs below the tip, spreading, oblong or obliquely ovate-oblong, excavate at proximal base, the larger ones nearly free, all deeply crenate or crenately lobed, the lobes minutely bicrenate; segments rigidly herbaceous, brownish or dull grayish green in drying, opaque, glabrous above, beneath persistently yellowish-strigose along the oblique prominulous veinlets, the hairs septate; sori 3 or 4 in fertile segments, seated between the lobes, marginal, 1 mm. broad; indusia about 0.3 mm. broad, herbaceous, yellowish, translucent, concave, not covering the sporangia.

Type in the U. S. National Herbarium, nos. 1,077,327–9, collected on open slopes of Morne de Ouésanne, vicinity of Furcy, Haiti, altitude 1,300 meters, June 13, 1920, by E. C. Leonard (no. 4796).

Among known members of the genus *H. hispaniolica* need be compared only with *H. nigrescens* Hook., which differs in its lax, dark green blades of thin texture, its much more strongly aculeate rachises (the spines dark), its broader and much closer secondary pinnae and pinnules, and its closer and more numerous segments (these nearly glabrous beneath), the lobes deeply dentate-crenate.

Hypolepis hispaniolica attains a much greater size than indicated in the description. This is shown by a section from a large primary pinna collected in Barahona Province, Dominican Republic, by Fuertes (no. 1335b), which is nearly 60 cm. broad and evidently came from a nearly 5-pinnate blade. There is a similar range of dissection in *H. nigrescens*, according to age of plant and position of pinnae. Mature fronds of *H. nigrescens* are often as much as 2.5 meters broad. Those of *H. hispaniolica* doubtless attain similar dimensions.

Pteridium arachnoideum (Kaulf.) Maxon.
Pteris arachnoidea Kaulf. Enum. Fil. 190. 1824.
Vicinity of Mission, Fonds Varettes, altitude 1,000 meters and above, forming thickets 2.5 to 3 meters high, on mountain slopes, *Leonard* 2883. Near Furcy, altitude 1,300 meters, common, forming thickets 2 meters high or more, *Leonard* 4339, 4591.

This is common throughout the mountains of tropical America, rarely descending below 1,000 meters, and is commonly listed as a variety (var. *esculentum*) of *P. aquilinum*. It is, however, amply distinct from the Australasian plant described by Forster in 1786 as *Pteris esculenta*, and is readily distinguished from related American forms, among other characters, by the transverse arclike costal auricles that connect the segments and apical pinnules.

Asplenium heterochroum Kunze.
A single collection: Mission, Fonds Varettes, altitude 1,000 meters and above, on dryish cliff, *Leonard* 5333.

Apparently new to Hispaniola. Previously known from Bermuda, Cuba, Porto Rico, and peninsular Florida.[3]

Asplenium resiliens Kunze.
Vicinity of Mission, Fonds Varettes, altitude 1,000 meters and above, occasional, on steep rocky slopes, *Leonard* 3984. Base of Mt. Tranchant, near Furcy, altitude 1,300 meters, on rocks, *Leonard* 4368a.

The specimens are indistinguishable from continental material ranging from the southern United States to Guatemala. Known also from the Blue Mountains of Jamaica, at 1,500 to 1,800 meters elevation.[4]

Struthiopteris tuerckheimii (Brause) Maxon.
Blechnum tuerckheimii Brause in Urban, Symb. Ant. **7**: 159. 1911.
Mission, Fonds Varettes, *Leonard* 3915. Near Furcy, occasional or locally common in bracken thickets and on rocky slopes, *Leonard* 4319, 4461, 4496.

The specimens cited agree closely with an example of the type collection from Constanza, Dominican Republic (*Türckheim* 2976), though some of them are larger. The species belongs under *Lomaria*, which Brause merges with *Blechnum*, following Diels and Christensen. Miss Broadhurst in treating the species of this alliance has regarded *Lomaria* as a distinct genus, and has shown[5] the necessity of adopting for it the name *Struthiopteris* (Hall.) Scop., 1760.

Dryopteris abbottiana Maxon, sp. nov.
Subgenus *Lastrea*. Rhizome wanting, presumably ascending; fronds 80 to 90 cm. long, laxly ascending; stipe (from base to lowest vestigial pinnae) about 20 cm. long, fuliginous to dull stramineous, sulcate, densely grayish-puberulous, and bearing a very few, distant, pale brownish, linear scales

[3] Contr. U. S. Nat. Herb. **17**: 140, 141. *f. 2*. 1913; **24**: 62. 1922.
[4] Contr. U. S. Nat. Herb. **17**: 143, 144. 1913.
[5] Bull. Torrey Club **39**: 257–259. 1912.

(2 to 4 mm. long); blades lanceolate, 65 to 70 cm. long, 16 to 24 cm. broad in the lower third, long-acuminate at apex, very abruptly reduced at base, with about 3 pairs of glanduliform vestigial pinnae, these mostly 1.5 mm. long, alternate, distant, the lowest one 20 cm. below the blade proper; rachis greenish-stramineous, densely whitish-puberulous, the hairs persistent; pinnae 20 to 25 pairs below the tip, alternate, slightly oblique, nearly straight, linear, up to 13 cm. long and 2 cm. broad, attenuate (the tip subcaudate, serrate to subentire), sessile, pinnatifid to about 1 mm. from the costa, the costa elevated beneath, densely antrorse-hirtellous on both surfaces; main segments of larger pinnae about 25 pairs, narrowly oblong, up to 12 mm. long, 3 to 4 mm. broad, slightly oblique, subfalcate, acutish distally, with acutish open sinuses, the basal ones of the lower 2 or 3 pairs (above the vestigial pinnae) greatly reduced; margins narrowly revolute, antrorsely ciliate; midveins elevated and antrorsely hirtellous beneath; veins 10 to 12 pairs, oblique, mostly straight (the basal ones curved), elevated on both surfaces, glabrous beneath, conspicuously scabrous above; leaf tissue membranous, above dull green and minutely scabrous, beneath paler, sublustrous, eglandulose, obscurely pilosulous, the hairs erect, delicate, persistent; sori small, 9 to 12 pairs, medial, round, 10 to 15-sporangiate, the sporangia glabrous; indusia very minute, reduced to a few short connate hairs, concealed by the sporangia.

Type in the U. S. National Herbarium, no. 1,077,220, collected on Morne de Ouésanne, near Furcy, Haiti, altitude 1,300 meters, in bed of a wet ravine, June 11, 1920, by E. C. Leonard (no. 4709). Two additional fronds of the type number are preserved. Represented also by *Leonard* 4739a, from the same locality.

Dryopteris abbottiana is related to *D. demerarana* (Baker) C. Chr., of British Guiana, and *D. rusbyi* C. Chr., of Bolivia, both of which are of similar proportions, with the blade very abruptly reduced to vestigial pinnae at the base, and have the leaf tissue appressed-pubescent above. *D. demerarana* is distinguished by its broader, less attenuate, less deeply pinnatifid, and mostly subopposite pinnae, its fewer, closer, broader, and less acute segments, its fewer veins (7 to 9 pairs, the proximal basal one often forked), and its distinctly supramedial sori. The sori have been described as exindusiate, but the remnant of an indusium, consisting of a few persistent connate hairs, is invariably evident in a specimen of the type collection (*im Thurn* 356). *Dryopteris rusbyi* is perhaps more nearly related, but is at once distinguished by its horizontal *opposite* pinnae and its close-set patent segments. All three species form a natural subgroup which must be studied in connection with *D. rustica*, as that species is interpreted by Christensen.

Dryopteris rudis (Kunze) C. Chr.

Mission, Fonds Varettes, altitude 1,000 meters, in thickets on mountain slopes, *Leonard* 3868; occasional in open pine woods, *Leonard* 3918. Morne de Ouésanne, near Furcy, altitude 1,300 meters, common in damp thickets, *Leonard* 4662; occasional, on steep mossy banks, *Leonard* 4626.

Collected in the same region also by W. Buch (nos. 1698 and 1706). Not reported from Hispaniola by Christensen.

Dryopteris haitiensis (Brause) Urban & Maxon, sp. nov.

Dryopteris subincisa haitiensis Brause, Ark. för Bot. **17**[7]: 67. 1922.

Rhizome wanting; frond (incomplete) 1 meter long, rigidly erect; stipe (incomplete) 33 cm. long, 5 mm. thick, nearly terete, light brown, opaque, persistently paleaceous, the scales divaricate, linear-attenuate, 10 to 13 mm. long, about 1 mm. broad at base, brown, rigid, retrorsely denticulate toward the tip; blades lanceolate, acuminate, 67 cm. long, 18 cm. broad at base, 28 cm. broad at middle, bipinnate-pinnatifid, the primary rachis divaricate-paleaceous like the stipe, the scales smaller; pinnae about 13 pairs, spreading, the lowermost 10 cm. long, 5.5 cm. broad at base, narrowly triangular, inequilateral, basiscopic, borne 10 cm. below the second pair; middle pinnae subopposite, 5 to 6 cm. apart, strongly catodromous, sessile, triangular-oblong, long-acuminate, nearly equilateral, 14 to 16 cm. long, about 5.5 cm. broad at base, pinnate-pinnatifid, the rachis densely hirsutulous with short several-celled brownish hairs on both surfaces, beneath scantily divaricate-paleaceous, the scales brown, lance-attenuate, 3.5 to 5 mm. long, minutely denticulate throughout; pinnules of middle pinnae about 13 pairs, distant, subarcuate, the basal ones the largest, subsessile, elongate-triangular, deeply pinnatifid (lobes about 5 pairs), those beyond less deeply pinnatifid, semiadnate, those of the outer half merely crenate, broadly adnate or dilatate at base, the apical ones passing gradually into the coarsely crenate tip of the pinna; costae of pinnules slightly strigose-hirsutulous above at base, beneath sparingly yellowish-hirsutulous throughout; lobes rounded-oblong to semicircular, the margins narrowly revolute, rather freely ciliate; leaf tissue brownish green, thick-herbaceous, glabrous on both surfaces; sori large, numerous, nonindusiate, mostly borne in distant groups of 2 or 3, only the largest lobes having 3 or 4 pairs each.

Type in the herbarium of the Berlin Botanical Museum, collected at Ma Blanche, Morne de la Hotte, Département du Sud, Haiti, altitude about 1,400 meters, October 7, 1917, by E. L. Ekman (no. 556). A single pinna is preserved in the U. S. National Herbarium (no. 1,145,498).

The present species, which was indicated by Dr. Urban as possibly new, shows no very close alliance with *D. subincisa* (Willd.) Urban, with which it was associated in a varietal sense by Brause. It is immediately distinguished by its small size and lanceolate blades, the basal pinnae being distant and somewhat reduced, whereas in all forms of *D. subincisa* the blade is deltoid, the basal pinnae being the largest and best developed of all. It belongs to the group of *D. subincisa*, but among the species thus far described it appears to have no very near relatives.

Dryopteris asterothrix (Fée) C. Chr.

A single specimen: Mission, Fonds Varettes, altitude about 1,000 meters, on dry cliffs, *Leonard* 5337.

A rare but widely distributed species known from a few plants collected

in Cuba, Jamaica, Guatemala, Costa Rica, and Venezuela, and more recently the Dominican Republic (*Eggers* 2503, 2528). New to Haiti.

Dryopteris alata (L.) Maxon.

Polypodium alatum L. Sp. Pl. 1086. 1753.

Vicinity of Mission, Fonds Varettes, altitude about 1,000 meters, occasional at edge of trail through thickets, April 23, 1920, *Leonard* 3797.

This species, founded by Linnaeus on Petiver's *Polypodium serratum majus costa alata* (pl. 7, fig. 13), has been practically unknown, at least in so far as actual specimens are concerned, for well over 200 years. The name *Polypodium alatum* L. is referred to *Dryopteris scolopendroides* (L.) Kuntze in Christensen's Index Filicum, but is mentioned in none of his papers on *Dryopteris*, published subsequently. That the reference is incorrect is clearly shown by the above-cited specimens. These agree well with Plumier's plate 84 (the prototype of the Petiver illustration), representing a plant from the Leoganne region, Haiti, and certainly are specifically distinct.

From *D. scolopendroides* in all its forms *D. alata* differs conspicuously in size and in its much greater subdivision. The blades are 40 to 50 cm. long and 7 to 10 cm. broad, and are pinnatifid almost to the rachis, being in fact subpinnate nearly throughout, the segments *distant*, lanceolate, 4 to 6 cm. long, long-acuminate, and themselves lobed half-way to the costa, each lobe with a strongly elevated costule and 5 to 9 pairs of oblique, pinnately arranged veins. The blades are thus once more divided than those of *D. scolopendroides;* as to venation the primary segments correspond to whole blades of the latter species. In addition, most of the blades end abruptly in huge viviparous buds, as opposed to the long-attenuate non-proliferous tips of *D. scolopendroides*. These characteristic differences are shown by illustrations which will accompany the report on Mr. Leonard's collection.

Polystichum machaerophyllum Slosson.

Morne de Ouésanne, near Furcy, altitude 1,300 meters, common on a wooded slope, *Leonard* 4779.

Known previously only from eastern Cuba (*Shafer* 3262, 4127, 8096; *Wright* 828 in part; *Pollard, Palmer & Palmer* 237). It is a very close ally of *P. ilicifolium* Fée, of the same region.

Polystichum polystichiforme (Fée) Maxon.

Rivière Boucandie, Furcy, occasional in damp shady ravine, *Leonard* 4443. Morne de Ouésanne, Furcy, altitude 1,300 meters, on wet rocks, *Leonard* 4718.

Known hitherto from Cuba, Jamaica, and Porto Rico. Some of the Haitian specimens are larger than other Antillean material at hand, and approach the continental *P. platyphyllum* (Willd.) Presl, as that collective species is still regarded.

BOTANY.—*New species of plants from Salvador. III.*[1] PAUL C. STANDLEY, National Museum.

Zamia herrerae Calderón & Standl., sp. nov. (Fig. 1).

Leaves few, the petioles slender, scarcely half the length of the rachis, glabrous, furnished with a few remote stout spines 1–2 mm. long, similar spines present also on the rachis; leaf rachis very slender, about 35 mm. long; leaflets about 50, nearly linear, 15–22 cm. long, 8–13 mm. wide, 17 to 21-nerved, thick, very lustrous, paler beneath, the margins bearing a few distant (about 2 cm. apart) appressed spine-tipped teeth, the lower third of the blade entire, the blades gradually attenuate from the lower third to the tip; inflorescence and fruit unknown.

Type in the U. S. National Herbarium, no. 1,165,680, collected in the vicinity of Sonsonate, Salvador, July 17, 1923, by Dr. Salvador Calderón (no. 1682).

Although known only from sterile material, there is little doubt that the present plant represents an undescribed species of this interesting genus, of which several other Central American representatives are known. This is probably the first *Zamia* to be reported from the Pacific coast of Central America.

The species is named in honor of Sr. Dr. Héctor Herrera of Sonsonate, an enthusiastic scientist and promoter of scientific work, whose delightful hospitality we have experienced upon the occasion of several visits to that city.

Aeschynomene calderoniana Standl., sp. nov.

Slender shrub, 1–2 m. high, with few branches, the young branchlets densely puberulent; stipules caducous; petioles short (mostly 6–10 mm.), the leaf rachis 2–5.5 cm. long, finely appressed-pubescent or glabrate; leaflets 5–10 pairs, oval-oblong or oblong-obovate, 9–18 mm. long, 5–8 mm. wide, broadly rounded at apex and obscurely mucronate, obliquely rounded at base, nearly sessile, rather thick, when young sparsely setose-strigose but soon glabrate, the venation beneath laxly reticulate and somewhat prominent, the costa central or nearly so; flowers in few-flowered axillary racemes shorter than the leaves, dark purple, the rachis densely puberulent, the pedicels about 4 mm. long; calyx 2–2.5 mm. long, covered with short appressed whitish hairs; standard petal 6–7 mm. long, suborbicular, densely whitish-sericeous outside, the other petals nearly as long, glabrous; joints of the fruit 1 or 2, semiorbicular or nearly so, 10–15 mm. long, 6–8 mm. wide, thin, nearly smooth, densely whitish-strigillose or finally glabrate.

Type in the U. S. National Herbarium, no. 1,136,211, collected on dry open hillside above Santa Ana, Salvador, January, 1922, by Paul C. Standley (no. 20367).

[1] Published by permission of the Secretary of the Smithsonian Institution. The last preceding paper of this series was published in this Journal, Vol. 13, pp. 436–443.

Fig. 1. *Zamia herrerae* Calderón & Standl.
(About one-fourth natural size)

A well-marked species, not closely related to any of those previously reported from Central America or Mexico. It is named in honor of Sr. Don Oscar Núñez Calderón, who was a helpful and highly esteemed companion during nearly a month spent in the western departments of Salvador.

Machaerium marginatum Standl., sp. nov.

Shrub 3–4 m. high, the trunk armed with large stout spines; young branchlets thick and succulent, sparsely pilose; stipules 8–12 mm. long, oblong-lanceolate, compressed, thick and indurate, spinose, densely pilose-sericeous on both surfaces; leaves long-petiolate, the petioles slender, sparsely pilose or glabrate; leaflets subopposite, about 13, the petiolules stout, 4–5 mm. long, sparsely short-pilose or glabrate, the blades oblong or oblong-elliptic, 8–13 cm. long, 3–5.5 cm. wide, abruptly acuminate, rounded at base, thick, very lustrous, when young sparsely pilose and puberulent beneath along the costa, elsewhere glabrous, the venation conspicuous but little elevated, the margin cartilaginous-thickened; inflorescence terminal, forming a very large panicle, much branched, the branches copiously short-pilose or somewhat tomentose, becoming glabrate, bearing also numerous scalelike trichomes, these lance-subulate, broadened at base, pilose, terminating in a slender yellow bristle, the scales upon the ultimate branchlets setiform; bracts similar to the stipules, indurate; flowers in short racemes, the pedicels about 2 mm. long; bractlets lanceolate or ovate, nerved, bearing numerous subulate-setiform yellowish hairs; calyx 5 mm. long, obtuse at base, sparsely yellow-setose, obliquely 5-dentate, the teeth broadly triangular, obtuse, finely appressed-pubescent; petals dirty pinkish white, the standard 8–9 mm. long, abruptly recurved, densely whitish-sericeous outside, the other petals glabrous, the keel petals slender-clawed, united above; ovary linear, strongly curved, densely appressed-pilose, the style slender, glabrous.

Type in the U. S. National Herbarium, no. 1,137,184, collected on a dry brushy slope near San Vicente, Salvador, altitude about 400 meters, March, 1922, by Paul C. Standley (no. 21381).

The type specimen consists of flowering material, without leaves, the shrub being leafless at flowering time. The description of the leaves is drawn from *Standley* 20146, collected on the Finca Colima, Sierra de Apaneca, Departamento de Ahuachapán, in January of the same year. The second collection consists only of leaves, but there is little doubt that it represents the same species. The vernacular name given at the Finca Colima was *sangre bravo*.

Machaerium marginatum is perhaps related to *M. pachyphyllum* Pittier, a Panaman species, but it is not likely to be confused with any plant of the genus previously reported from Central America. Sterile specimens collected by the writer at Quiriguá, Guatemala, in March, 1922, (no. 23935) represent either the same or a very closely related species, and I have also seen specimens from Oaxaca, Mexico, which are perhaps conspecific.

Banisteria rosea Standl., sp. nov.

Large woody vine, the branches slender, brownish, the young branchlets densely and loosely sericeous but soon glabrate; petioles 3-6 mm. long, glabrate; leaf blades elliptic or elliptic-ovate, 2.5–6 cm. long, 1.5–3.5 cm. wide, acute to very obtuse at apex, rounded or obtuse at base, thin, when young densely and loosely appressed-pilose but soon glabrous, pale beneath, bearing near the base of the blade 2–4 sessile glands; inflorescence of lax few-flowered axillary panicles 4–6 cm. long, their branches slender, loosely tomentose or finally glabrate, the bracts leaflike, 5–7 mm. long; pedicels slender, mostly 4–6 mm. long, bearing 2 small bractlets about the middle; sepals 2.5–3 mm. long, oval, rounded at apex, sericeous, the glands scarcely half as long as the sepal body; petals 4–5 mm. long, pink; samaras 1 or 2, about 2.5 cm. long, densely or sparsely strigose, the wing thin, dilated toward the apex and 7–8 mm. wide, thickened along the dorsal margin, the body coarsely reticulate-veined, not crowned.

Type in the U. S. National Herbarium, no. 1,137,424, collected in a ravine at the base of the Volcán de San Vicente, near the town of San Vicente, Salvador, March, 1922, by Paul C. Standley (no. 21663). Also collected in flower at La Unión in February, 1922, *Standley* 20653.

Related to *B. retusa* (Donn. Smith) C. B. Robinson and *B. purpurea* L. *Banisteria rosea* is a handsome vine of the lowlands of Salvador, its abundant flowers at a distance resembling apple blossoms. At La Unión the vernacular name of *florecita de pensamiento* was given for it.

Acalypha salvadorensis Standl., sp. nov.

Plants apparently annual, more than 30 cm. high, erect, the stems densely cinereous-puberulent, with elongate internodes; stipules minute; petioles very slender, 1.5–3.5 cm. long, puberulent and with a few short gland-tipped hairs (these present also upon the stems); leaf blades ovate or broadly ovate, 3–4.5 cm. long, 1.5–3 cm. wide, acute or the lowest obtuse, rounded or obscurely emarginate at base, evenly and rather finely crenate, thin, on the upper surface sparsely setulose-hirsute and scaberulous, beneath finely pubescent; plants monoecious, the staminate spikes axillary, subglobose, usually less than 2 mm. long, borne on slender peduncles 2–4 mm. long; pistillate spikes terminating the main branches and much reduced ones (about 1 cm. long) borne on short leafy axillary branches; terminal spikes very dense, 2.5–5 cm. long, about 1 cm. thick, the rachis densely cinereous-puberulent; bracts reniform, 5–7 mm. long, sparsely white-hirsute and densely short-pilose, also with numerous short gland-tipped hairs, the margin with about 8 very short obtuse teeth; styles divided into numerous slender filiform branches; capsule 2 mm. in diameter, broader than high, obtusely lobate, finely pubescent; seeds subglobose, grayish, closely foveolate.

Type in the U. S. National Herbarium, no. 1,165,685, collected in San Salvador, Salvador, July, 1923, by Dr. Salvador Calderón (no. 1741).

The plant is of a decidedly weedy and ordinary appearance, but it is not matched by an herbarium material available, nor does it agree with any description with which it has been compared.

Croton payaquensis Standl., sp. nov.

Shrub, 1 m. high or less, or often nearly wholly herbaceous, sparsely branched, the branches densely covered with a pubescence of white or yellowish, appressed, sessile trichomes consisting of numerous radiating branches; stipules subulate, entire, caducous; petioles stout, 5–12 mm. long, densely stellate-tomentose; leaf blades oblong-ovate to ovate-oval, 2.5–7 cm. long, 1.5–4 cm. wide, rounded at apex, broadly rounded or subcordate at base, thick, obscurely glandular-denticulate, densely stellate-tomentose on both surfaces or in age glabrate and green above, whitish beneath, eglandular; flower spikes axillary, sessile, sometimes 6 cm. long and many-flowered but often very short and few-flowered, the flowers short-pedicellate; staminate flowers subglobose in bud and 1–1.5 mm. in diameter, petaliferous; stamens about 8, the receptacle densely white-pilose; pistillate calyx sparsely stellate-pubescent or glabrate, the five lobes lance-oblong, subequal, acute; young fruit densely stellate-tomentose, becoming glabrate; styles bipartite, the branches densely stellate-pubescent below, glabrous above.

Type in the U. S. National Herbarium, no. 1,151,991, collected on the Cerro de la Olla, on the Guatemalan frontier near Chalchuapa, Salvador, in 1922 by Dr. Salvador Calderón (no. 1024). The following additional specimens have been examined:

SALVADOR: Santa Ana, *Standley* 20351. Laguna de Maquigüe, *Standley* 20941.

Similar in general appearance to *C. cortesianus* H.B.K., which, however, is conspicuously distinct in its acute leaves which are glabrous on the upper surface. At Maquigüe the vernacular name was given as *friega-plato.* The specific name is derived from Payaquí, a name given in preconquest times to the region about the Lake of Güija.

Ophellantha Standl., gen. nov.

Small trees, the indument scant, of simple hairs; leaves alternate, petiolate, membranaceous, penninerved, remotely denticulate; stipules 2, small, spinose, persistent; flowers monoecious, long-pedicellate, solitary or fasciculate on axillary spurs; staminate calyx 5-parted, the lobes in anthesis slightly imbricate; petals 5, distinct, entire, much longer than the calyx, sessile, ciliate; disk large, densely short-hirsute; stamens numerous (50 or more), irregularly inserted over the disk, the filaments elongate, filiform, glabrous; anthers small, 2-celled, dehiscent by 2 introrse slits, each cell bearing at the apex a short filiform appendage; rudimentary ovary absent; sepals of the pistillate flower 5, becoming large and leaf-like after anthesis; petals not seen; margin of the disk very shallowly 5-lobate; ovary 2-celled, sessile; styles 2, stout, nearly or quite distinct, bifid for one-third their length; ovules solitary; capsule 2-celled, the cells loculicidally and septicidally bivalvate, separating from the persistent flattened column; seeds large, ecarunculate, smooth or nearly so; cotyledons broad and plane, the endosperm fleshy.

Type species, *Ophellantha spinosa* Standl.

Ophellantha is apparently to be referred to the *Acalypheae-Chrozophorinae* of the family Euphorbiaceae, and in the key to the genera of that group

given by Pax in Engler's Pflanzenreich[2] it would run at once to *Speranskia*, a genus of herbaceous plants occurring in China. *Ophellantha* is clearly distinct in various important characters from each genus of the group treated by Pax. All the other genera of the group have a 3-celled capsule, but it may be that a 2-celled fruit is not constant in the Salvadorean plant.

Ophellantha spinosa Standl., sp. nov.

Tree, 4.5–6 m. high, the branchlets slender, brownish, with few large elevated lenticels, the young branchlets rather sparsely furnished with short acicular appressed hairs; stipular spines 3–5 mm. long; much enlarged at base; leaves on young branchlets alternate, no branches of the preceding years fasciculate at the nodes, the petioles slender, 10–14 mm. long, pubescent like the branchlets; leaf blades elliptic or ovate-elliptic, 5–9 cm. long, 2.5–5.5 cm. wide, acute or short-acuminate, with blunt tip, acute at base and decurrent upon the petiole, thin, green above, paler beneath, furnished along the nerves with appressed acicular hairs, glabrate elsewhere, densely appressed-ciliate, obscurely and remotely glandular-denticulate, the margin often slightly repand; pedicels slender, 1.2–1.8 cm. long; staminate sepals broadly ovate, 1–1.5 mm. long, appressed-pilosulous; petals oval, green, about 5 mm. long, rounded at apex, glabrous, ciliolate; disk 4 mm. in diameter, the filaments 4–5 mm. long; pistillate sepals oblong-elliptic, in fruit about 1.5 cm. long, obtuse or acutish, denticulate, 5-nerved, foliaceous, green, glabrate, sparsely ciliolate; styles 5–6 mm. long, appressed-setulose; capsule 1.5 cm. long, appressed-setulose or glabrate, smooth, the walls very thick; seeds about 10 mm. long and 6–7 mm. broad, glabrous, the surface irregularly mottled with brown and grayish.

Type in the U. S. National Herbarium, no. 1,137,579, collected in a thicket on the mountain slopes above Izalco, Departamento de Sonsonate, Salvador, March, 1922, by Paul C. Standley (no. 21819).

The vernacular name of the tree was given as *limoncillo*.

Triumfetta calderoni Standl., sp. nov.

Shrub or tree, often 6–8 m. high, with smooth pale bark and spreading open crown; stems densely covered with a double indument of fine stellate hairs and of coarse stiff spreading ones; petioles 3–7 cm. long, densely tomentose; leaf blades mostly ovate or rounded-ovate, 9–15 cm. long, 5–11 cm. wide, rather abruptly acuminate or long-acuminate, rounded or subcordate at base, coarsely and irregularly crenate-dentate, sometimes obscurely 3-lobate or angulate, stellate-setulose or stellate-tomentulose on the upper surface or finally glabrate, beneath pale and usually densely stellate-tomentose; panicles terminal and axillary, often very large in fruit, the branches densely stellate-tomentose; pedicels 2–3 mm. long or in fruit longer; sepals oblong-linear, 4–5 mm. long, not appendaged at apex, minutely tomentose outside; petals oblong, glabrous, about one-third as long as the sepals; fruit 5–7 mm. long (including the bristles), covered with numerous very slender bristles, these densely pilose with stiff spreading whitish hairs.

[2] IV, **147**: 10. 1912.

Type in the U. S. National Herbarium, no. 1,151,087, collected in the vicinity of San Salvador, Salvador, December, 1921, by Dr. Salvador Calderón (no. 78). The following additional collections also represent the same species: SALVADOR: San Salvador, *Calderón* 354, 1257; *Standley* 19114. San Marcos, Departamento de San Salvador, *Standley* 22782. Tonacatepeque, Departamento de San Salvador, *Standley* 19475.

A well-marked species, characterized by its densely pilose fruit and minute petals.

Abutilon calderoni Standl., sp. nov.

A much-branched shrub, 1–3 m. high, the branchlets terete, covered with a minute close grayish tomentum; petioles slender, 5–11 cm. long; leaf blades broadly ovate-cordate to orbicular-cordate, 8–17 cm. long, 5.5–14 cm. wide, rather abruptly acuminate or long-acuminate, deeply cordate at base, shallowly and finely crenate, often rather remotely so, sometimes obscurely 3-lobate near the apex, thin, green above, thinly and extremely minutely stellate-pubescent, beneath covered with a fine close grayish stellate tomentum; flowers orange, mostly in large open pyramidal terminal panicles; pedicels slender, 1.5–3.5 cm. long, jointed near the base; calyx lobes ovate, 5–6 mm. long, acute, densely pubescent, appressed or spreading in fruit; petals 12–15 mm. long, glabrate outside, spreading; stamen tube about 7 mm. long, stellate-pubescent, much enlarged below; carpels 10 or 11, 8 mm. long, 2 or 3-seeded, obtuse or rounded at apex, stellate-tomentose.

Type in the U. S. National Herbarium, no. 1,152,613, collected in waste ground in San Salvador, Salvador, in 1923 by Dr. Salvador Calderón (no. 1639). The following additional specimens have been examined: SALVADOR: San Salvador, *Standley* 22676. Volcán de San Salvador, *Standley* 22984.

A specimen collected by Dr. Calderón at Zacatecoluca in March, 1922, (no. 330) differs from the typical form only in having the branches, especially those of the inflorescence, pilose with long spreading stiff hairs. It is probably only a variant form, and may be known as **Abutilon calderoni** var. **longipilum** Standl. (type, U. S. Nat. Herb. no. 1,151,348). The vernacular name of the Zacatecoluca plant is *malva.*

Abutilon calderoni is a relative of *A. giganteum* (Jacq.) Presl, which is distinguished by its substantially larger carpels.

SCIENTIFIC NOTES AND NEWS

The Petrologists' Club and the Geological Society of Washington were hosts to a number of visiting geologists on the occasion of a field trip made December 30 to the diabase quarry at Goose Creek, near Belmont Park, Virginia, and the limestone quarries at Leesburg. Features of especial interest were the diabase-pegmatitic segregations at the Goose Creek quarry and the extensive metamorphism of the Triassic limestone conglomerate at Leesburg. E. V. Shannon, of the National Museum, E. Sampson, of the Geological Survey, and E. T. Wherry, president of the Mineralogical Society, acted as guides.

Miss KATHERINE D. KIMBALL, assistant in the Grass Herbarium of the Department of Agriculture, was killed by an automobile January 12. Miss Kimball had been connected with the Department about five years.

Dr. WILLIAM M. MANN, of the Federal Horticultural Board, returned January 14 from Mexico, where he has been studying the fruit fly situation. Dr. Mann left early this month on an extended trip to Colombia, Costa Rica, and Guatemala.

On January 12 Dr. WILLIAM BOWIE, Chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, gave a lecture before the Royal Canadian Institute of Toronto, Canada, *What do we know about the Earth's crust?*

The January, 1924, number of the Geographical Journal, (London) contains two articles on isostasy; one is by Dr. William Bowie, Chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, entitled *Abnormal densities in the Earth's crust disclosed by analysis of geodetic data,* and the other by Capt. ALBERTO ALESSIO, Hydrographer of the Italian Navy, entitled *Doubts and suggestions on terrestrial isostasy.* These two papers were read at a meeting of the Royal Geographical Society of Great Britain, at a meeting on November 12, 1923, and were followed by discussions, printed after the articles, by eminent English scientists. The printed discussions were by Prof. Arthur R. Hinks, Sir Frank Dyson, G. W. Lamplugh, Dr. Morley Davies, Sir Sidney Burrard, R. D. Oldham, Sir Charles Close, Colonel Crosthwait, Dr. J. W. Evans and Dr. Harold Jeffreys.

J. S. DILLER, who has held an appointment as geologist on the Geological Survey for more than forty years, retired from the government service on December 31.

An expedition, headed by RICHARD O. MARSH of Brockport, N. Y., sailed January 12 for Panama, for the purpose of studying a tribe of blonde Indians said to inhabit the Chucunaque Valley in the eastern part of that republic, and of carrying on general scientific exploration. Other members of the party are JOHN L. BAER, of the National Museum, anthropologist, H. L. FAIRCHILD, of the University of Rochester, geologist, and Dr. C. BREDER, of the American Museum of Natural History, ichthyologist. All physical data and specimens of ethnological, archaeological, or anthropological nature collected by the expedition are to become the property of the National

Museum. It is expected that a detail of topographers and engineers from the Engineering Corps will accompany the party, and that airplanes will be used for transportation from the Zone into the interior.

The Petrologists' Club met on January 15 at the home of F. E. Wright. Dr. T. A. Jaggar, of the Volcano Observatory, Hawaii, spoke on *Lava tides*. The following officers were elected for the year: Governing Committee, C. N. FENNER, C. S. ROSS, E. V. SHANNON; Secretary-Treasurer, E. B. SAMPSON.

Dr. H. W. GILLETT, who has been engaged in research on alloys at the Ithaca station of the Bureau of Mines, has been appointed chief metallurgist of the Bureau of Standards, succeeding Dr. G. K. Burgess who is now director of the Bureau.

Dr. T. WAYLAND VAUGHAN, formerly of the Geological Survey, left Washington January 20 to take up his work as director of the Scripps Institute of Biological Research at La Jolla, California.

WOODROW WILSON, the most distinguished member of the ACADEMY, twenty-eighth President of the United States, died February 3. Mr. Wilson was elected an honorary member of the ACADEMY March 5, 1918, in view of his contribution to the science of history.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 MARCH 4, 1924 No. 5

ZOOLOGY.—*A new family of spined millipeds from Central China.*

O. F. COOK and H. F. LOOMIS, Department of Agriculture.

Reduction of the milliped fauna is one of the effects of deforestation. Exposure to extreme conditions of temperature and dryness are fatal to the more delicate creatures that live in the humus layer of the soil. The cultivated regions of Central China have few millipeds, but remnants of a larger fauna are still to be found in districts that are sufficiently mountainous or broken to interfere with farming or to prevent complete deforestation and denudation of the soil. Such protection for the humus fauna is afforded in the "Lu Shan," or Lu mountains, south of Kiukiang in the province of Kiang-si, a small district of broken country surrounded by fertile plains that no doubt have been cultivated intensively for thousands of years. Some of the valleys and declivities of these mountains are so steep and rocky that any possibility of former cultivation is excluded. Even the gentler slopes of the valleys are not well suited to the Chinese methods of farming and apparently have never been used for this purpose, though the whole of this small mountain area probably has been ravaged for fuel through many centuries.

Undoubtedly the Lu Shan country was covered orginally with heavy forests but these probably were cut down and replaced long ago by a growth of coppice like that of the present day, with the trees held strictly in check by charcoal burning. In the more sheltered places the protection afforded by the coppice has been sufficient to maintain the humus layer, and thus to permit the survival of millipeds, including the remarkable new form that is here described. This creature was most abundant near a locality known as "Three Trees," the site of a small Buddhist monastery where two giant Cryptomerias and an enormous gingko have been allowed to grow, apparently the only trees that have been spared by the Chinese in the whole district.

Recently, however, one of the Lu Shan valleys has been occupied by a summer settlement of missionaries at Kuling. Here trees are protected from the charcoal burners so that a renewal of the forests is shown to be possible, if charcoal burning were regulated.

That special conditions were necessary for the survival of this peculiar milliped would hardly be doubted when its characteristics are considered. In comparison with other diplopoda such an animal obviously would be placed at a disadvantage by the excessive armature of the body, each of the segments being provided with a pair of relatively enormous spine-like processes, shaped like the trunk of a tree with four or five branches. Also the legs and antennae are much elongated, projecting on each side two or three times the width of the body. Thus the animal requires for its movements a much larger space than any other milliped of similar size, and is the most extreme example among millipeds of the tendency to exaggeration of extremities that usually is associated with the habit of living in caves.

Except that the creature is a member of the large group of 20-segmented millipeds (Order *Merocheta*), its relationships are not apparent, so that a new family as well as a new genus is proposed. So great is the departure of this milliped from any other known form that rather extensive descriptions seem justified in the interest of morphology, paleontology, and evolution, as well as of systematic zoology.[1]

Hylomidae, new family.

Body small, slender, moniliform, more than 10 times as long as wide, not closely coiled; head very large and prominent, wider than the body, the antennal sockets below the middle and close together; antennae and legs very long and slender, projecting on each side for more than twice the width of the body.

Segments with a dorsal armature of 2 transverse rows of spines, separated by a rather shallow transverse depression, but lacking a distinct groove or furrow; lateral carinae replaced by very large erect or strongly ascending branched processes, equal in length to the width of the body cavity (see fig. 1); repugnatorial pores on the lateral processes of segments 5, 7, 9, 10, 12, 13, 15 to 19; sterna rather broad, not spined; the spiracles with very prominent raised rims, forming distinct papillae on anterior segments.

Last segment triangular, the apex narrowly truncate, projecting beyond the anal valves, with a large setiferous spine on each side and several smaller setiferous spines.

Secondary sexual characters of males: body more slender and with longer appendages; sternum of segment 5 with a large protuberance; legs of segment 6 with the third joint crassate above the middle, bearing a large thumb-like process on the ventral side at the base of the thickened portion of the joint.

[1] An enlarged photograph of *Hylomus* is being published in the Journal of Heredity for January, 1924, with a discussion of evolution in millipeds.

The long branched processes replacing the lateral carinae are the unique feature at once separating this family from any other of the existing types of millipeds hitherto recognized. These processes may be considered as carinae since they bear the repugnatorial pores near the base, but there is no resemblance to the usual form of the carinae in this order, as lateral ridges or expansions of the dorsal surface. The processes stand at the ends of a transverse dorsal depression and taper rapidly from a circular base occupying about one-third of the length of the posterior subsegments. Only among the fossil types of millipeds have such extreme modifications of the segments been reported.

The group relationships are not obvious, but a provisional association with the *Scytonotidae* is suggested by the general form and proportions of the body, as well as by the secondary sexual characters, though the same legs are not specialized in *Scytonotus*, nor the same joints of the legs, joint 5 being chiefly modified in *Scytonotus* instead of joint 3, as in *Hylomus*. Similar processes occur in the third joint of the legs at segments 5 or 6 in several tropical genera, as *Cnedmodesmus* from Africa and *Priodesmus* from South America.

Hylomus, new genus.

Diagnosis: Characters as stated above in the family description, which may be supplemented as follows:

Head much wider than the first segment, projecting in front for more than the length of the first segment; antennae separated by less than the width of a socket, very long and slender; joints 1 and 7 short, the others long; joints 2 and 6 slightly shorter than joints 3 to 5.

First segment with a branched or compound process on either side, a series of 6 large, forwardly directed, simple spines along the anterior margin, 4 smaller spines along the posterior margin, and 2 very small spines near middle of segment; segments 2, 3, and 4 shorter than any of the others; segments 2 and 3 with a distinct oblique flange below, that of segment 2 somewhat embracing the sides of the head.

Subsequent segments with a large, erect or ascending process on each side, about as long as the diameter of the body; processes of anterior segments with 4 prongs, of the middle segments with 5 prongs, an interior transverse row of 4 small simple spines near front margin, more distinct on the anterior and posterior segments, very small on the middle segments; a posterior row of two large erect-retrorse spines close to the posterior margin; all spines with a seta on one side near the tip; anterior subsegments very minutely and evenly reticulate; posterior subsegments minutely granular over the dorsal and lateral surface, including the base of the spines.

Penultimate segment with the compound processes smaller and more simple, the inner branch becoming separate, giving 4 spines on the posterior margin, the anterior row of 4 smaller spines crossing the middle of the segment.

Last segment subtriangular, projecting beyond the anal valves, the apex distinctly truncate with a large conical, setiferous tubercle on either side and 8 smaller setiferous tubercles.

Anal valves but little inflated, with 2 setiferous tubercles.

Repugnatorial pores small, located on the outer face of the lateral processes between the base and the first branch.

Legs very long and slender, the longest equaling or 2 or 3 times the diameter of the body; joint 3 much exceeding the others; sterna rather broad, minutely granular, pilose, with a slight transverse impression.

Gonopods rather slender, subarcuate, with 2 slender subequal, subapical simple branches directed obliquely mesad (see fig. 2).

Slow-moving creatures; when disturbed forming a loose coil with the legs out.

The type species is *Hylomus draco*, new species, from Central China. The generic name alludes to the armature of the body, consisting of large dendritic spines.

Hylomus draco, new species.

Length from 12 mm. in small males to 22 mm. in large female; width of body cavity 1 mm. in males, 1.5 mm. in females, of segments with spines 2 mm.

Color of living animals purple or pink, vertex and clypeus brownish on the deeply colored specimens; anterior segments to about the 7th with the large spines distinctly pinkish or purplish, more deeply tinged than the segments, also a small area of the segment at the base of the spines deeply tinged; remainder of body purplish pink, salmon or buff; some specimens distinctly brownish below the spines, with a pink band across the posterior border, others nearly white or pale purplish throughout, the spines pink; also a narrow dark median line may be shown, the skeleton being very delicate and translucent; antennae and terminal joints of the legs rather light brownish, basal joints of legs white; legs 6 and 7 of males with the thickened third joint more deeply colored.

Vertex with a very pronounced median sulcus; the surface moderately hairy, beset with minute sharp tubercles or spicules; clypeus also hairy and tuberculate; labrum with strongly converging sides, a distinct emargination and three prominent teeth, also a submarginal row of 10 to 12 bristles.

Antennae moderately pilose; joint 1 short and stout; joint 2 slightly curved; joint 6 slightly clavate; last joint subconic, about one-fifth as long as joint 6.

First segment about as wide as the second segment and twice as long, semielliptic, evenly rounded in front, the posterior margin nearly straight; much narrower than the head, seen from the front as a small cap or crown scarcely wider than the vertex, except for the ascending lateral spines, which are somewhat smaller than on other segments and have only 2 branches; other spines as stated in the generic description, a distinct median sulcus beginning at the anterior margin and extending across two-thirds of the segment.

Segments 2 to 4 decidedly shorter than those following; segment 2 the shortest, the anterior row of 4 small spines more distinct; segment 4 with a very large prominent spiracle.

Segments 2 to 18 with a large, erect or somewhat oblique process on each side of the posterior half of the subsegment, equal or exceeding in length the diameter of the body in the male, or approximating the diameter in the female; each process with 4 arms or branches, 2 near the middle or below, the posterior branch larger, and 2 apical branches, sometimes a fifth branch between the middle and terminal spines. The lateral processes are bent slightly forward on the anterior segments, are more upright on the middle segments, and are recurved on the posterior segments. Between the lateral processes is an anterior row of 4 very small spines, and 2 large simple recurved posterior spines, one on each side, near the base of the process. All of the spines with a very minute seta on one side, near the tip.

Posterior segments with the large processes reduced to nearly simple spines, the upper branches smaller and the lower branches separate, so that the subterminal segments have a series of 4 spines along the posterior margin; also the anterior row of 4 small spines is more distinct on the subterminal segments.

Last segment produced beyond the anal valves and slightly decurved, obliquely truncate, and slightly thickened at the apex, with 4 long apical setae; on either side a large divergent setiferous spine and 2 smaller setiferous spines above and between the large spines; also an anterior transverse row of 8 small setiferous tubercles, 4 on each side, one of these near the margin and only slightly removed from the preanal scale.

Anterior subsegments with the surface densely but finely reticulate; posterior subsegments thickly beset above with minute sharp-pointed spicules, including the surface of the large processes; on the sides of the posterior subsegments the spicules are replaced by minute rounded granules.

Anal valves weakly inflated, with 2 vertical grooves at the base of each, not reaching the middle of the valve, the grooves separated by a prominent ridge; surface covered with fine granulation, but the margins of the valves

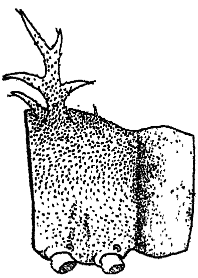


Fig. 1

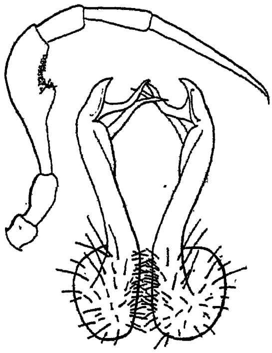


Fig. 2

Hylomus draco, new species

Fig. 1.—Lateral view of tenth segment of male; fig. 2.—gonopods and seventh leg of male.

smooth, compressed, and slightly elevated; 2 small setiferous tubercles present, one near the middle of the valve and another above.

Preanal scale considerably broader than long, subtriangular, the apex broad and faintly emarginate, a long hair rising from each angle, the surface finely granulate and with minute transverse wrinkles.

Legs with joints 1 and 2 short, 3 and 6 very long, 4 about as long as 2, and 5 twice as long; rather sparsely pilose; sterna with a transverse groove distinct on each side but nearly obliterated in the middle, rather sharply angled at the bases of the legs but not distinctly spined.

Secondary sexual characters of the male:

Body smaller and more slender.

Spines of the body larger and more projecting, and the legs longer in proportion to the size of the body than in the female.

First pair of legs shorter and more crassate than those of the female.

Second pair of legs with a small conic tubercle on the inner-posterior side of the first joint bearing the aperture of the seminal duct; third and fourth pairs of legs not modified.

Fifth pair of legs with joint 3 slightly clavate and with a small rather abruptly rounded protuberance on the inner side just above the middle. The tubercle and adjacent surface are more densely pilose but the hairs not forming a distinct tuft.

Sixth pair of legs with joint 3 more strongly clavate and bending inward; a long, thick, bluntly rounded protuberance at the middle on the inner side with a tuft or brush of long hairs at the apex and on the inner face.

Seventh pair of legs with joint 3 still more crassate and arcuate, also with a protuberance on the inner side near the middle somewhat smaller than that of the previous pair of legs, and with a smaller brush of long hairs; also the surface of the joint along the sinus above the protuberance is coated with very short hairs extending from the base of the protuberance nearly to the end of the joint (see fig. 2).

On the sternum between the fourth and fifth pairs of legs is a very large, somewhat fungiform protuberance, bearing 2 tubercles directed forward and outward, a laterally directed tubercle on either side, and an apical broad, short tubercle directed slightly backward and with a large, deep pit or pore indenting the apex; the pore surrounded and crossed by very long hairs; also such hairs on the lateral and anterior tubercles.

Locality and habitat: Lu Shan district, Kiang-si province, Central China, south of Kiukiang; in moist humus near stream below the Yellow Dragon Temple, Kuling, altitude 4,000–4,500 feet. Numerous specimens were collected by O. F. Cook and H. F. Loomis, October 16, 1919. The type is in the U. S. National Museum.

BOTANY.—*New species of* Passiflora *from tropical America.*[1] ELLSWORTH P. KILLIP, National Museum.

Of the 13 species of *Passiflora* described herewith four are from Mexico and Central America, and are based upon material received by the National Museum since the publication of an earlier paper[2] by the writer. The remaining species have been detected in the course of a revision of the Passifloraceae of northern South America.

Passiflora dioscoreaefolia Killip, sp. nov.

Stem slender, subtriangular, sulcate, pubescent at nodes with a few hooked hairs, otherwise glabrous; stipules semi-ovate, 1 cm. long, 0.5 cm. wide, attenuate at apex, slightly undulate at margin; petioles up to 2.5 cm. long, finely pubescent with hooked hairs, biglandular about 3 mm. below apex, the glands short-stipitate, 2 mm. long, 2 mm. wide; leaves oblong-ovate, 8 to 10 cm. long, 4 to 5.5 cm. wide, entire, abruptly acuminate at apex, cordate at base (sinus about 5 mm. deep), 5 or 7-nerved, entire and slightly thickened at margin, membranous, sparsely pubescent with hooked hairs above, glabrous beneath; peduncles solitary or in pairs, up to 3 cm. long, 1-flowered, slightly pubescent with hooked hairs; bracts setaceous, 3 to 4 mm. long, scattered; flower 5 cm. wide (when expanded); sepals ovate-lanceolate, 2 cm.

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Journ. Washington Acad. Sci. 12: 255–262. 1922.

long, 1 cm. wide at base, slightly cucullate at apex, greenish-white (?) and slightly pubescent without, white, longitudinally striate with deep purple within; petals oblong or oblong-spatulate, about 1.2 cm. long, 0.6 cm. wide, obtuse, white, marked like the sepals; filaments of faucial corona in a single series, filiform, 1.5 cm. long, white, spotted with deep purple; middle corona plicate, the margin lobulate, slightly incurved; basal corona saucer-shaped, 2 mm. high, crenulate at margin; gynophore and stamens mottled and streaked with deep purple; ovary narrowly ovoid, short-stipitate, glabrous.

Type in the U. S. National Herbarium, no. 1,167,023, collected at La Palma, Costa Rica, July 8, 1923, by H. E. Stork (no. 436).

The flowers of this species and the presence of glands at the apex of the petioles indicate relationship with *P. bryonioides*, *P. heydei*, and *P. pringlei*. It is distinguished from all the species of that group by its entire leaves.

Passiflora podadenia Killip, sp. nov.

Stem subquadrangular, sulcate, hispidulous; stipules semi-ovate, 10 mm. long, 6 to 7 mm. wide, cuspidate at apex; petioles up to 5 cm. long, hispid-hirsute, biglandular below the middle (glands pyriform, 1.5 mm. thick, borne on long slender hispidulous stalks 6 to 7 mm. long); leaves 4 to 6 cm. long, 5 to 7 cm. wide, deeply 3-lobed (middle lobe oblanceolate, 2 to 2.5 cm. wide, narrowed toward base, short-acuminate), deeply cordate at base, 5 or 7-nerved, subentire toward ends of lobes, coarsely dentate near base, hispidulous with pellucid hairs, dark green above, paler beneath; peduncles in pairs, about 2 cm. long; bracts linear-attenuate, 4 mm. long, 0.6 to 0.9 mm. wide, entire; flowers 3 to 3.5 cm. wide, white, spotted and streaked with dark purple; sepals ovate-lanceolate, about 15 mm. long, 8 mm. wide, slightly cucullate at apex; petals oblong or oblong-spatulate, 7 to 10 mm. long, 3 mm. wide, obtuse; filaments of faucial corona in a single series, narrowly linear, 1 cm. long; middle corona erect, 3 mm. high, white, the margin incurved, minutely denticulate; basal corona membranous, adnate to flower tube, the margin erect; ovary ovoid, tapering at apex, stipitate, hispidulous, at length glabrate.

Type in the U. S. National Herbarium, no. 1,166,599, collected at the Hacienda San Antonio, Colima, Mexico, altitude 1,200 meters, September, 1923, by B. P. Reko (no. 4839).

The long, slender stalks of the glands at once distinguish this species from its nearest relatives of the subgenus *Plectostemma*. The shape of the leaves and general aspect of the plant suggest *P. bryonioides* H. B. K. *Passiflora adenopoda* DC. likewise has long-stalked glands, but the lacerate bracts, differently shaped leaves, and larger flowers at once prevent possibility of confusion with *P. podadenia*.

Passiflora miraflorensis Killip, sp. nov.

Stem terete below, subquadrangulate above, densely pubescent; stipules narrowly linear or setaceous, up to 7 mm. long, falcate; petioles up to 1.5 cm. long, glandless; leaves semiorbicular in general outline, 5 to 6 cm. long (midrib), 6 to 8 cm. wide (between tips of lobes), 2 or 3-lobed (middle lobe shorter than lateral lobes; lobes ovate-lanceolate, acute, cuspidate), cordate at base, membranous, dark green and sparsely hirtellous above, paler and

densely appressed pubescent beneath; peduncles 1 to 1.5 cm. long; bracts borne near the middle of the peduncle, 3 to 4 mm. long, entire or bifurcate; flowers about 2.5 cm. wide, greenish yellow; sepals linear-lanceolate, 10 to 12 mm. long, 3 to 4 mm. wide at base; petals linear, about 5 mm. long; filaments of faucial corona in 2 series, the outer filiform, 4 to 6 mm. long, radiate, the inner narrowly linear, 1.5 mm. long, erect; middle corona closely plicate; basal corona annular; ovary globose densely pilose-hirsute with white or yellowish hairs; fruit depressed-globose, 0.8 cm. long, 1 cm. wide, densely pubescent; seeds obovoid, 3 to 4 mm. long, 2 mm. wide, transversely 6 or 7-grooved, the ridges rugulose.

Type in the U. S. National Herbarium, no. 1,141,393, collected at "Miraflores," in the Central Cordillera, east of Palmira, Department of El Valle, Colombia, altitude 2,100 meters, May 27, 1922, by E. P. Killip (no. 6135).

The foliage of this plant very closely resembles that of *P. rubra* and *P. capsularis*. The presence of bracts, the small fruit, and the rugulose ridges of the testa of the seeds show that it is far removed from that group, however.

Passiflora laticaulis Killip, sp. nov.

Plant glabrous throughout; stems strongly flattened, grasslike, 3 to 6 mm. wide, scabrous at margin; stipules setaceous, 2 to 2.5 mm. long; petioles filiform, 1 to 1.5 cm. long, glandless; leaves 2-lobed (a vestige of an intermediate lobe occasionally present, the lateral lobes divaricate at an angle of nearly 180°, linear or lanceolate, acute or acuminate, mucronulate), up to 1.5 cm. long (along midrib) and 8 cm. wide (between tips of lateral lobes), subpeltate at base, membranous, ocellate beneath, light green when dry; peduncles filiform, up to 5 cm. long; flowers up to 3 cm. wide; sepals linear-lanceolate, 1.5 cm. long, 0.5 cm. wide, obtuse, greenish-yellow; petals linear-lanceolate, 1 cm. long, 0.3 to 0.4 cm. wide, obtuse, white; filaments of faucial corona in 2 series, the outer filiform, 1 cm. long, the inner narrowly linear, capitellate, 4 mm. long; middle corona slightly plicate, white; basal corona reduced to a very low, hardly conspicuous ring, close to the base of the middle corona; ovary ovoid, glabrous; fruit globose, up to 1.2 cm. in diameter; seeds obovoid, 2.5 to 3 mm. long, 1.5 to 2 mm. wide, transversely 5 or 6-grooved.

Type in the herbarium of the New York Botanical Garden, collected on a grassy bank, near "Susumuco," southeast of Quetamé, Department of Cundinamarca, Colombia, altitude 1,100 to 1,500 meters, September 5, 1917, by F. W. Pennell (no. 1723).

This species is at once recognized by its broad grasslike stems. The general shape of the leaves and structure of the flower indicate relationship with *P. misera* and *P. erubescens*, but those species have nearly terete stems and rounded leaf lobes. From *P. erubescens* it is further distinguished by its much larger flowers and longer peduncles.

Passiflora standleyi Killip, sp. nov.

Herbaceous vine; stem subquadrangular, striate, glabrous below, minutely pubescent above; stipules narrowly linear-falcate, 2 mm. long, 0.3 mm. broad; petioles 1.5 to 2.5 cm. long, glabrous, glandless; leaves oblong, bilobed one-half to two-thirds their length, 2.5 to 5 cm, long along midnerve, 6 to 12 cm.

along lateral nerves, 4 to 5 cm. wide between apices of lobes (lobes lanceolate, 1.5 to 2 cm. wide, obtuse or acutish, apiculate), rounded or subcuneate at base, 3-nerved, ocellate, reticulate-veined, glabrous; peduncles slender, 2 to 3 cm. long, glabrous; bracts setaceous, 2 to 3 mm. long, borne within 1 cm. of apex of peduncle; flowers 3 to 4 cm. wide, bluish purple; sepals ovate-lanceolate, 1 to 1.5 cm. long, 4 to 5 mm. wide, obtuse, membranous; petals half as long as sepals, obtuse, membranous; filaments of faucial corona capillary, in two series, those of the outer 4 to 7 mm. long, blue at base, white, spotted with blue at apex, those of the inner very numerous, 4 to 5 mm. long, white; middle corona membranous, closely plicate, minutely fimbrillate at margin; basal corona annular, 1 mm. high; gynophore 0.6 to 1 cm. high, glabrous; anthers pale yellow; ovary subglobose, glabrous; styles filiform, 5 mm. long; stigmas reniform, 1 mm. wide.

Type in the U. S. National Herbarium, no. 1,138,548, collected on the Volcán de San Salvador, Salvador, at an altitude of about 1,000 meters, April 7, 1922, by Paul C. Standley (no. 22821). Specimens collected at the same locality by Calderón (April, 1922), and on the Volcán de San Vicente (*Standley* 21475) are also to be referred to this species.

The foliage of *Passiflera standleyi* resembles that of *P. ornithoura*, likewise found in Salvador by Mr. Standley, and of *P. tuberosa*, a native of Trinidad and northern South America. From these species it differs in its bluish purple flowers and the elongate filiform filaments of the outer corona. Both *P. ornithoura* and *P. tuberosa* have white flowers with short strapshaped filaments. *Passiflora standleyi* is distinguished from *P. salvadorensis* by its proportionally narrower leaves and a totally dissimilar coronal structure. Vernacular name: *calzoncillo*.

Passiflora cobanensis Killip, sp. nov.

Stem slender, 4 or 5-angulate, finely pubescent with curved, grayish hairs; tendrils weak, densely pubescent; stipules lanceolate, subfalcate, 8 to 9 mm. long, 1.5 to 2 mm. wide, acuminate, conspicuously 5 to 7-nerved; petioles 8 to 10 mm. long, glandless, pubescent; leaves ovate-lanceolate, 7 to 10 cm. long, 2.5 to 3.5 cm. wide, unlobed, acuminate, rounded at base, entire at margin, 3-nerved, faintly reticulate-veined, without ocellae, membranous, glabrous and sublustrous above, finely pubescent beneath with curved grayish-brown hairs; peduncles 1.5 cm. long; bracts not seen; flowers about 2.2 cm. wide, greenish; sepals linear-lanceolate, 10 mm. long, 2 mm. wide, acute, pubescent without; petals lanceolate, 5 mm. long, 2 to 3 mm. wide, obtuse, greenish; filaments of faucial corona in a single series, linear-clavate, 2.5 mm. long; middle corona membranous, plicate; basal corona annular; ovary obovoid, subangulate, densely tomentellous; styles filiform, sparingly pilosulous; stigmas reniform, finely pubescent.

Type in the U. S. National Herbarium, no. 1,083,984, collected between Chamá and Cobán, Department of Alta Verapaz, Guatemala, at an altitude of 950 meters, July 26, 1920, by Harry Johnson (no. 411).

The exact position which this species occupies in the subgenus *Plectostemma* is difficult to determine. The absence of glands either on the petiole or in the form of ocellae on the leaf blades suggests its relationship with *P. capsularis*, *P. rubra*, *P. rovirosae*, and *P. costaricensis*. The only other entire-leaved

species of this subgenus from Central America, *P. auriculata*, *P. lancearia*, and *P. dioscoreaefolia*, differ markedly in floral characters, as well as in the shape of the leaves.

There is a specimen in the National Herbarium, collected near San José, Costa Rica, by H. Pittier (Inst. Phys.-Geog. Costa Rica 16675), which closely resembles *P. cobanensis* but its leaves are unequally 2-lobed to below the middle. The lobes are lanceolate, acuminate, 1.5 to 2 cm. wide, the distance between the tips of the lobes being about 7 cm. Possibly *P. cobanensis* is a species with dimorphic leaves, similar, in this respect, to *P. praeacuta* and *P. dispar* of South America.

Passiflora gracillima Killip, sp. nov.

Plant glabrous throughout; stem slender, subterete below, angulate above; stipules setaceous, 2.5 to 3 mm. long; petioles up to 3 mm. long, bearing at apex 2 minute sessile glands; leaves oblong or ovate-oblong, 2.5 to 5 cm. long, 2 to 3.5 cm. wide, unlobed, rounded or occasionally subemarginate at apex, truncate at base, entire at margin, 1-nerved, reticulate-veined, subcoriaceous, dark green and lustrous above, green or subglaucous beneath; peduncles solitary in the axils of the leaves, 2 to 4 cm. long, very slender, bearing at apex 2 pedicelled flowers, and terminating in a slender tendril; flowers 1.5 to 2 cm. wide, greenish-yellow; sepals linear-lanceolate, 10 mm. long, 3 mm. wide, obtuse; petals 7 to 8 mm. long, 2 mm. wide; filaments of faucial corona in 2 series, those of the outer filiform, 4 to 5 mm. long, the inner capillary, 1.5 mm. long; middle corona plicate, erose at margin; basal corona cupuliform, 1 mm. high; ovary ovoid, obscurely 6-angled; fruit ellipsoidal, 3 cm. long, about 1.3 cm. in diameter, 6-angled.

Type in the U. S. National Herbarium, no. 1,141,457, collected at "Pinares," above Salento, Department of Caldas, Colombia, altitude 2,900 to 3,200 meters (Central Cordillera), August 3, 1922, by F. W. Pennell (no. 9393). Additional specimens were collected at the same locality by Dr. Pennell, under the numbers 9224 and 9317.

This species belongs to the small group of passion flowers with a 2-flowered peduncle which terminates in a tendril. It is most closely related to *P. tryphostemmatoides* Harms, differing in its oblong leaves, elongate peduncles, and ellipsoidal rather than ovoid, fruit. The filaments of the faucial corona, moreover, are in 2 series, not in a single series.

Passiflora gleasoni Killip, sp. nov.

Plant glabrous throughout, except bracts and ovary; stipules setaceous, 8 mm. long, early deciduous; petioles up to 2 cm. long, biglandular about 5 mm. below apex, the glands sessile, 2 mm. in diameter; leaves oblong, up to 16 cm. long, and 9 cm. wide, abruptly acuminate at apex, truncate at base, remotely and shallowly glandular-serrulate, or subentire, subcoriaceous, lustrous above; peduncles up to 5 cm. long; bracts oblong-elliptic, about 2 cm. long, 4 to 5 mm. wide, cuspidate-acuminate, glandular-serrate at apex, finely puberulent on both surfaces, reddish (when dry); flowers about 8 cm. wide; sepals lanceolate, 3 to 3.5 cm. long, about 1 cm. wide, obtuse, not awned at apex; petals linear, 2 cm. long, 0.5 cm. wide, obtuse, much thinner

than sepals; filaments of faucial corona in 3 series, those of the two outer capillary, 4 to 5 cm. long, those of the third series linear, 1 mm. long; middle corona membranous, 7 to 8 mm. high, inflexed from base, the upper third lacerate-cleft; secondary middle corona a low annular ridge; basal corona borne close to base of gynophore, barely 2 mm. high, the margin denticulate; stamens oblong, 7 mm. long, 4 mm. wide; ovary ovoid, finely ferruginous-tomentellous.

Type in the U. S. National Herbarium, no. 1,123,194, collected along the Pomeroon River, Pomeroon District, British Guiana, January 14–20, 1923, by J. S. de la Cruz (distributed by H. A. Gleason, no. 2963). There is also a specimen of this collection in the herbarium of the New York Botanical Garden.

The foliage of this species resembles that of *P. nitida* H. B. K., but the bracts and flowers are much different. *Passiflora nitida* has larger, rounded bracts, and the outer filaments of its faucial corona are thick and fleshy. In *P. gleasoni* the bracts are much narrowed at both ends, resembling those of *P. vitifolia*, and the corona filaments are extremely slender.

Passiflora capparidifolia Killip, sp. nov.

Plant glabrous throughout, except bracts and ovary; stem terete or nearly triangular above; stipules narrowly linear, 6 to 7 mm. long, 0.5 mm. wide, acute, subcoriaceous; petioles up to 8 mm. long, biglandular at apex, the glands sessile; leaves oblong, 8 to 10 cm. long, 2.5 to 3 cm. wide, rounded and mucronulate at apex, rounded or subcuneate at base, 1-nerved, reticulate-veined, thick-coriaceous, lustrous; bracts 3 to 3.5 cm. long, 2 cm. wide, obtuse and often cleft at apex, slightly narrowed at base, slightly glandular toward apex, about 7-nerved, glabrous and sublustrous without, finely puberulent within; flowers 8 to 10 cm. wide; sepals lanceolate, about 4 cm. long, 1 cm. wide, obtuse, slightly keeled toward apex (keel terminating in a murco 2 mm. long), subcoriaceous; petals linear-oblong, 2.5 to 3 cm. long, 1.5 cm. wide, obtuse, white (?), conspicuously nerved, thin-membranous; filaments of faucial corona in several series, the outermost filiform, 1.5 to 2 cm. long, those of the second series compressed, 3.5 to 4 cm. long, 1.5 to 2 mm. wide, attenuate, white, banded with violet, the succeeding series composed of tubercles or of minute threads barely 0.5 mm. long; middle corona membranous, the margin entire, incurved; basal corona annular; gynophore enlarged about 4 mm. above base; ovary ellipsoïdal, finely white-tomentellous.

Type in the U. S. National Herbarium, no. 1,122,154, collected on bank of the Potaro River, Tumatumari, British Guiana, July 4–6, 1921, by H. A. Gleason (no. 328). An additional sheet of this collection is in the herbarium of the New York Botanical Garden.

Allied to *P. laurifolia* this species is distinguished by its much narrowed, more obtuse leaves, and by the more slender threads of the outer two series of the faucial corona. The floral structure of *P. capparidifolia* is also much like that of *P. oblongifolia* Pulle, of Surinam, known to the writer only from description. The leaves of that species apparently are much different and the flowers are said to be borne on long pedicels in elongate racemes.

Passiflora pedata stipularis Killip, subsp. nov.

Stipules spatulate, 8 to 12 mm. long, 5 to 7 mm. wide, the margin fimbriate-lacerate nearly to base; otherwise like *P. pedata* L.

Type in the U. S. National Herbarium, no. 1,187,263, collected in the vicinity of Mene Grande, State of Zulia, Venezuela, October 31, 1922, by H. Pittier (no. 10609).

Passiflora pedata, because of its pedately parted leaves and fimbriate bracts, is distinct from all other species of *Passiflora*. The specimen collected by Mr. Pittier apparently is identical in leaf shape, flower structure, and form of the bracts with *P. pedata*, but the stipules are foliaceous and deeply fringed. In typical *P. pedata* they are setaceous, barely 5 mm. long.

Passiflora pennellii Killip, sp. nov.

Plant glabrous throughout; stem slender, terete, or subangulate above; stipules subreniform, 9 to 10 mm. long, 4 to 5 mm. wide, aristate, coriaceous, reticulate-veined; petioles up to 2.5 cm. long, 6 to 8-glandular (glands stipitate, 1.5 mm. long); leaves 5 to 7 cm. long, 7 to 10 cm. wide, 3-lobed to 1 or 1.5 cm. from the base (lobes lanceolate, 1 to 2 cm. wide, acute or obtusish, glandular in the sinuses, the middle lobes narrowed at base), subpeltate and subtruncate or subcordate at base, 5-nerved, reticulate-veined, coriaceous, green on both surfaces, shining above; peduncles up to 5 cm. long; bracts ovate-lanceolate, 8 to 10 mm. long, 3.5 to 5 mm. wide, acute, slightly narrowed at base, borne about 8 mm. below base of flower; flowers 5 to 6 cm. wide; sepals oblong-lanceolate, 1.5 to 1.8 cm. long, 7 to 8 mm. wide, obtuse, aristate outside just below apex, reticulate-veined, green without, white within; petals oblong-lanceolate, 1.8 to 2 cm. long, 1 cm. wide, obtuse, white; filaments of faucial corona white, in several series, the two outer narrowly liguliform, 2 to 2.5 cm. long, 0.8 mm. wide, the succeeding 2 or 3 series narrowly ligulate, 5 to 6 mm. long, 0.4 mm. wide; middle corona 6 to 7 mm. long, the lower half membranous, deflexed the upper half erect, filamentose; basal corona cupuliform, 1 mm. high, crenulate at margin; ovary ovoid.

Type in the herbarium of the New York Botanical Garden, collected on a moist slope in forest near "Susumuco," southeast of Quetamé, Department of Cundinamarca, Colombia, altitude 1,200 to 1,400 meters, September 5, 1917, by F. W. Pennell (no. 1729).

The only Colombian species with which this might be confused is *P. trisulca* Mast. The shape of the leaves and stipules of the two are evidently very similar. The leaves, however, are much smaller and are not glaucescent beneath. A more important point of difference lies in the middle corona. In *P. trisulca* this is said to be plicate, and on this basis the species was placed in the subgenus *Plectostemma*. The middle corona of *P. pennellii* is not plicate, its general structure indicating close relationship with *P. stipulata*, *P. pruinosa*, *P. cyanea*, and *P. choconiana*. Of these species it resembles *P. choconiana*, of Guatemala, most closely, differing in narrower leaf lobes, the absence of a glaucous hue on the under surface of the leaves, the broader outermost corona filaments, and the shorter and stouter gynophore.

Passiflora hastifolia Killip, sp. nov.

Plant densely hirsute throughout (except flowers) with stiff white hairs; stem terete; stipules subreniform, 1.2 to 1.5 cm. long, 0.5 to 0.6 cm. wide, aristate, coarsely dentate at base, subentire above; petioles up to 3 cm. long, bearing 2 to 4 stipitate glands about 1.5 mm. long; leaves 4 to 7 cm. long, 6 to 9 cm. wide, hastately 3-lobed (lobes acute, the middle lobe ovate-lanceolate, 2 to 3 times as long as the lateral lobes, 2 to 3.5 cm. wide, the lateral lobes divergent), subcordate, 5-nerved, minutely denticulate or subentire, membranous; peduncles not seen; bracts ovate, 1 to 1.3 cm. long, about 0.7 cm. wide, acute, glandular-serrate; flowers about 5 cm. wide; sepals 1.5 to 2 cm. long, 0.6 to 0.7 cm. wide, corniculate at apex, dark green without, white at margin, white within; petals oblong-lanceolate, 1 to 1.5 cm. long, 0.4 to 0.5 cm. wide, obtuse, white; filaments of faucial corona filiform, in several series, the outer 1 to 1.2 cm. long, pink at apex, white at middle, purple at base, the succeeding 4 or 5 series composed of numerous purple filaments 3 to 5 mm. long; middle corona inflexed at base, membranous below, filamentose above, the filaments erect; basal corona membranous, closely surrounding base of gynophore; ovary ovoid, glabrous, pruinose.

Type in the U. S. National Herbarium, no. 1,157,294, collected at Milluguaya, North Yungas, Bolivia, altitude 1,300 meters, December, 1917, by O. Buchtien (no. 4356).

Resembling *P. menispermifolia* H. B. K. and *P. nephrodes* Mast. in its dense pubescence and the general structure of the flower, this species is at once distinguished by its hastate leaves and its broad, ovate—not narrowly elliptic—bracts.

Passiflora buchtienii Killip, sp. nov.

Plant glabrous throughout; stem slender, wiry, 4 or 5-angular; stipules narrowly elliptic, 1 to 1.5 cm. long, 2 to 3 mm. wide, incised-serrate, the serrations cuspidate; petioles very slender, up to 1.5 cm. long, biglandular below middle, the glands 0.5 mm. long; leaves 2 to 3 cm. long, 2.5 to 4 cm. wide, 3-lobed to just below middle (lobes oblong, 6 to 8 mm. wide, cuspidate), rounded or slightly cuneate at base, 3-nerved, finely cuspidate-serrate, membranous; peduncles up to 2.5 cm. long, stout; bracts oblong, 1 to 1.5 cm. long, 5 to 6 mm. wide, obtuse, incised-serrate; flowers scarlet, the tube cylindric, 1.5 cm. long, 8 mm. wide at the slightly enlarged throat; sepals linear-lanceolate, about 5 cm. long, 6 mm. wide, slightly cucullate at apex, aristate just below apex (awn 6 mm. long); petals linear, about 4 cm. long, 5 mm. wide, obtuse; faucial corona 2-ranked, the outer rank filamentose (filaments 5 mm. long), the inner cylindric, 6 mm. long, membranous, the upper half lacerate-cleft; middle corona membranous, 6 mm. long, attached just below middle of tube, dependent, the margin retrorse, denticulate; basal corona none; gynophore slender, 4 cm. long; ovary narrowly ellipsoidal.

Type in the U. S. National Herbarium, no. 1,157,302, collected at Unduavi, North Yungas, Bolivia, altitude 3,300 meters, November, 1910, by O. Buchtien (no. 6004). Another specimen, no. 2896, possibly of the same collection, has also been examined.

Passiflora buchtienii belongs to the subgenus *Distephana*, its nearest relative being *P. vitifolia*. Its smaller, glabrous leaves, minute petiolar glands, the shape of its bracts and stipules, and the structure of the coronas at once distinguish it from *P. vitifolia*.

Passiflora retrorsa Killip, sp. nov.

Shrub (?); branches subquadrangular, the bark grayish, the older branches bearing at each node a spine-like retrorse appendage 1 to 1.5 cm. long, presumably an abortive tendril; branchlets finely puberulent; stipules setaceous, early deciduous; petioles 2 to 4 (or more?) mm. long, biglandular at apex, the glands sessile; main leaves not seen; branch leaves oval, 2.5 to 3.5 cm. long, 1.5 to 3 cm. wide, rounded at apex, rounded and slightly conduplicate at base, entire, penninerved, reticulate-veined, coriaceous, glabrous; peduncles solitary, 1 cm. long or less, finely puberulent; bracts not seen; flowers borne on elongate few-leaved axillary branches 15 to 35 cm. long, scarlet, the tube cylindric, 2 to 3 cm. long, 0.3 to 0.4 cm. wide, finely puberulent; sepals oblong, about 1.5 cm. long, 0.4 cm. wide, obtuse; petals oblong, 1 to 1.3 cm. long, 0.4 cm. wide, obtuse; filaments of faucial corona in 2 series, those of the outer subfalcate, 4 mm. long, acuminate, verrucose along one side, those of the second series filiform, 0.8 mm. long, capitellate; middle corona tubulate, 1 cm. long, arising about 2 mm. above base of flower, lacerate-cleft half its length; basal corona none; gynophore slender, up to 3 cm. long; ovary elliptic, finely puberulent, longitudinally 3-grooved; styles distinct to base, arising at summit of each ridge of ovary.

Type in the herbarium of the Academy of Natural Sciences, Philadelphia, no. 560,954, collected at Vuelta Triste, Río Manimo, Orinoco Delta, Venezuela, February 20, 1911, by F. E. Bond, T. S. Gillin, and S. Brown (no. 147).

This species is to be referred to the subgenus *Astrophea*, its closest relatives being *P. spicata* of Brazil and *P. spinosa* of Brazil and Peru. In *P. spicata* the flowers are borne in leafless racemes which are shorter than the leaves of the main stems; the leaves are 10 to 15 cm. long; and the flowers are larger, though of similar structure. In *P. spinosa* not only are the leaves and flowers much larger but the faucial corona filaments are subulate.

This may be the same as the British Guianan plant to which Klotzsch gave[3] the name *Tacsonia spinescens*, a nomen nudum.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE PHILOSOPHICAL SOCIETY

888TH MEETING

The 888th meeting was held at the Cosmos Club Auditorium on Saturday, October 6, 1923, with President White in the chair and 40 persons present.

Program: F. Wenner and A. W. Smith: *The measurement of low resistances by the Wheatstone Bridge.* (Presented by Mr. Wenner.) It was illustrated with lantern slides and was discussed by Messrs. Hawkesworth, Crittenden, and Tuckerman.

The paper gives a procedure that leads to a fairly high accuracy in the measurement of resistances as low as 0.01 or even 0.001 ohm with the Wheatstone bridge. It is pointed out that if a low resistance is to be definite it must have distinct current and potential terminals. An essential feature in the procedure consists in making the potential terminals of the low resistance two of the branch points of the bridge, to one of which a battery lead is con-

[3] Schomburgk, *Reisen in Guiana* p. 1168. 1848.

nected and to the other of which a galvanometer lead is connected. Consequently the terminal and lead resistances to the unknown are added to the resistances of the adjacent arms. Since these arms have resistances that are high compared with the unknown, the errors introduced into a bridge measurement by these terminal resistances are small compared with those existing when the ordinary procedure with the bridge is followed. In fact, a single measurement made in this manner gives sufficient accuracy for many purposes.

However, where higher accuracy is desired, it may be obtained by making two additional measurements with the same apparatus and correcting for the effect of the terminal resistances. Neither of these secondary measurements needs to be made with as high accuracy as the primary measurement, since they are made to obtain small corrections to be applied to the primary measurement. One of these secondary measurements is made with the battery lead transferred from the potential terminal of the unknown to the corresponding regular terminal of the bridge, the other with the battery lead in its original position on the potential terminal of the unknown, but with the galvanometer lead transferred from its position on the potential terminal of the unknown to the corresponding regular terminal of the bridge. These three measurements give three independent relations between the unknown, whose value is desired, the known resistance of the bridge arms, and two unknown connecting resistances. By an elimination of terms containing the connecting resistances, an approximate solution is obtained for the value of the unknown.

The paper contains data showing the accuracy obtained in measurements of resistances of the order of 0.01 ohm and 0.001 ohm. In the measurement of a resistance of the order of 0.001 ohm an accuracy of 0.6 per cent was obtained by the primary measurement alone and of 0.03 per cent when corrections obtained by the secondary measurements were applied. We do not consider the accuracy obtainable by this procedure comparable with that which may be realized with a Thompson double bridge. However, we present it as a convenient procedure to be used where the highest accuracy is not required and where more suitable apparatus is not available. (*Authors' abstract.*)

E. H. BOWIE: *Worldwide synoptic meteorological charts, and some inferences based thereon.* The paper was illustrated with lantern slides, and was discussed by Messrs. HUMPHREYS and PAWLING.

R. B. SOSMAN and H. E. MERWIN: *The effect of fine grinding on the density of quartz.* (Presented by R. B. Sosman.) It was discussed by Messrs. L. H. ADAMS and PRIEST.

In 1922 Ray[1] determined the heat of fusion of quartz at room temperature through the heats of solution of quartz and silica glass, and observed that very finely ground quartz had only about two-thirds as large a heat of fusion as coarsely crystalline quartz. Later[2] he compared the densities of coarse and finely ground quartz and found a lowering of density after grinding, which he interpreted as indicating a conversion of about one-third of the quartz into an amorphous form.

Johnston and Adams[3] could find no difference in density between coarse quartz crystals and quartz of a fineness which remained suspended in water

[1] Proc. Roy. Soc. **101A**: 509–516. 1922.

[2] Proc. Roy. Soc. **102A**: 640–642. 1923.

[3] Journ. Am. Chem. Soc. **34**: 563–584. 1912.

for some hours (size 20 μ and smaller). Messrs. Sosman and Merwin therefore attempted to repeat Ray's experiment by grinding quartz in the dry state for 12 hours in a mechanically operated agate mortar after it had been initially reduced to a fineness of 40 μ and smaller. Microscopic examination showed that the material was still all quartz, and although the amount was too small for accurate determination of density, it is hardly conceivable that this material could have either an abnormally low density or a low heat of fusion. Quartz ground under water for 14 hours also remained unchanged except for the size of the particles. The authors believe that there must be some concealed error in Ray's experiments. The hypothesis of a conversion of quartz into amorphous silica by grinding is certainly not tenable.

889TH MEETING

The 889th meeting was held at the Cosmos Club Auditorium on Saturday, October 20, 1923. It was called to order at 8:15 p.m. by Vice-President Hazard in the absence of President White. Forty-two persons were present.

Program: LEWIS V. JUDSON: *The work of the International Bureau of Weights and Measures.* The paper was illustrated with lantern slides, and was discussed by Messrs. CRITTENDEN, PAWLING, GISH, PRIEST, FOOTE, TUCKERMAN, BAUER, PIENKOWSKY, and FERNER. The International Bureau of Weights and Measures, located at Sevres, near Paris, was provided for by the International Metric Convention of 1875. Here are kept the international standards of weights and measures. A description of some of the buildings and apparatus used in the length measurement work was illustrated by lantern slides. The Brunner comparator for the comparison of the total length of meter bars, the expansion comparator, which has served not only for the determinations of thermal expansion of standards of length but also for the many researches in nickel steels carried out by the director, Dr. C. E. Guillaume, the 4 meter geodetic-bar comparator, and the comparator for standardizing geodetic tapes and wires were among the principal pieces of apparatus discussed. The need of continuing researches and investigations in the field of weights and measures was emphasized.

Referring to L. A. FISCHER's paper *The recomparison of the meter*, it was brought out that recent work has served as a tribute to Mr. Fischer for it is now known that the U. S. prototype has not changed in length at 0°C. since the original comparisons in 1889–90 but that two laboratory standards of the International Bureau, with which comparisons were made in 1903, had changed slightly and that the coefficients of expansion heretofore used for various meter bars, were not entirely correct.

PAUL R. HEYL: *Gravitational anisotropy in crystals.* The paper was illustrated with lantern slides, and was discussed by Messrs. PIENKOWSKY, TUCKERMAN, JUDSON, LAMBERT, HUMPHREYS, FOOTE, CURTIS, BAUER, PAWLING, HAZARD, PRIEST, and GISH.

Author's abstract: Einstein's theory of gravitation is based upon a fundamental postulate which he calls the principle of equivalence, and which asserts that gravitation and inertia are identical in nature, and hence indistinguishable. This, if true, is of the greatest theoretical importance, for gravitation has steadily refused to show any kinship to other physical phenomena.

Einstein's justification for this postulate was found in the gravity pendulum experiments of Newton and Bessel, and the torsion pendulum experiments of Eötvös, the results of which established to a high degree of precision

(about one part in 200 million) that the inert mass and the gravitational mass of a body were proportional; or, in other words, that gravitation is independent of the nature of the matter acted upon.

A still more delicate test of this postulate is possible in a crystal of one of the non-isometric systems; for in such a crystal every known physical property (except inertia, and possibly weight) varies with the axial direction in the crystal. It is therefore an interesting question whether, in such a crystal, gravitation will be found to align itself with inertia or will show some variability which will classify it with the great majority of physical phenomena. If, for example, such a crystal be weighed in different axial orientations with respect to the earth (which may be done with great precision) and any difference in weight be found in the different positions, Einstein would be wrong.

To test this point, crystals weighing a kilogram or more were thus weighed, the specimens covering all five non-isometric crystalline systems. The precision reached, in nearly every case, was one part in a billion (10^9). To this degree of precision no difference in weight was detected; the results have failed to prove Einstein wrong.

Incidentally this work has shown the practical possibility of using the gravity balance to compare kilogram weights with a precision of one part in 10^9. The best previous record of this kind, at the International Bureau, is seven parts in 10^9. This improved precision was reached by the use of the almost forgotten Poynting clamp, which permits the arrest of the beam and the change of weights without raising the knife-edge or altering the state of flexure of the beam.

890TH MEETING

The 890th meeting was held in the Cosmos Club Auditorium on Saturday, November 3, 1923. It was called to order by President White with 43 persons in attendance.

Program: L. B. TUCKERMAN: *A new optical lever system.* It was illustrated with lantern slides, and the new optical lever system was exhibited in an extensometer. The paper was discussed by Messrs. PAWLING, GISH, SLIGH, and WHITE.

Author's abstract: The behavior of optical lever systems may be treated theoretically by considering them as equivalent to systems of plane reflecting surfaces.

An even number of reflections at plane surfaces forms the image space by twisting the object space about a screw. An odd number combines this twist with reflection at a point on the axis of the screw. The direction of the screw axis and the angle of the twist depend only on the direction of the normals to the successive reflecting surfaces. The pitch of the screw and the position of the axis depend also on the position of the reflecting surfaces.

A collimated observing system which does not depend for its reading upon the pitch of the screw or location of its axis is therefore less sensitive to accidental disturbance than an uncollimated system such as the ordinary lamp and scale or telescope and scale. An auto-collimated system is especially free from disturbance.

Multiple mirror systems which depend for their reading upon changing the angle of the twist are freer from accidental disturbance than single (or equivalent multiple) mirror systems, which change the direction of the axis of the

screw. Especially free from disturbance are multiple mirror systems in which the angle of twist is small. The sextant is a two-mirror system of this type.

With an autocollimator a small angle of twist can only be used in connection with an odd number of reflections.

The new optical lever is a triple mirror system used with an autocollimator. It is practically insensitive to any disturbance which does not alter the angle between the two prisms which constitute the mirror system. It is therefore adapted for use on vibrating or even rotating parts.

An optical lever of the new kind was exhibited in an extensometer. It was sensitive to one fifty-thousandth of a radian, and the extensometer to 4 millionths of an inch.

O. H. GISH: *The system for recording earth-currents at the Watheroo Magnetic Observatory.* The paper was illustrated with lantern slides, and was discussed by Messrs. HEYL, BAUER, MAUCHLY, CURTIS, PAWLING, and WENNER.

Author's abstract: That natural electric currents flow in the Earth's crust at times of auroral displays is rather commonly known owing to their interference with telegraphic communication at such times. That similar though less intense currents exist at all times can be shown only by careful observations. The results published by Weinstein (1902) and by Bauer (1922) show more convincingly than any others that such currents may be observed with profit. Modern theories of terrestrial magnetism also imply the existence of general systems of electric currents in the Earth's crust, and especially do the recent developments of Chapman make promise of clarifying the problem and stimulating interest in further experimental as well as theoretical investigations of the subject.

A complete description of earth-currents requires a knowledge of the distribution of (1) the earth-resistivity and (2) the earth-current potential. It is the methods employed by the Department of Terrestrial Magnetism for determining (2) at its Observatory near Watheroo, Western Australia, that are here described.

The earth-current lines at Watheroo are so arranged that the earthed points determine a right angle, one limb of which extends due east and the other due north from the vertex. The point at the vertex is used as a common point of reference for the potentials of the other points. Two other points on each limb are situated, at present, 1.6 km. and 3.2 km. distant, rspectively, from the common point. The potential difference between the common point and the nearer point on each branch can be alternately recorded by means of overhead and underground lines, and thus a close comparison of the relative virtue of these two types of line may be made. Only overhead lines connect with the farther point on each branch. The overhead lines possess no features of special interest. The underground lines consist of leaded rubber-covered copper conductors in bituminized fiber conduit, placed at a depth of 46 cm. below the Earth's surface. The recorder is a modified Leeds and Northrup 12-point curve-printing potentiometer. A more detailed description is published in the September, 1923, number of the Journal of Terrestrial Magnetism and Atmospheric Electricity, volume 28, pages 89 to 108.

An informal communication on *Discarded theories which have been resurrected,* was presented by L. H. ADAMS. The communication was discussed by Messrs. WHITE, HUMPHREYS, MOHLER, and TUCKERMAN.

891ST MEETING

The 891st meeting was held in the Cosmos Club Auditorium on Saturday, November 17, 1923. The meeting was called to order by President White with 36 persons in attendance.

Program: H. L. DRYDEN: *The pressure of the wind.* The paper was illustrated by lantern slides, and was discussed by Messrs. CURTIS, LITTLEHALES, HAWKESWORTH, HUMPHREYS, PAWLING, and TUCKERMAN.

Author's abstract: The nature of the reaction between moving air and an obstacle to its progress is extremely complicated, even in the case of a uniform and a steady wind. Two characteristics of the phenomenon should be emphasized. First, the reaction consists of a surface distribution of pressure and the representation of the action by a single resultant force is only a convenient mathematical fiction. We should not be surprised to find that this resultant force does not intersect the body as happens in a great many cases. Second, when the air is at rest there is a distribution of pressure over the surface due to the normal atmospheric pressure. The effect of the air motion is a modification of this normal pressure. At some point the effect is an increase, at others a decrease. At all points a pressure acts, the air never pulling but always pushing, sometimes with intensity greater than normal and sometimes with intensity less than normal.

The distribution of pressure over several objects illustrates these points. Plates normal to the wind show the variation from point to point. Plates at angles illustrate the greater importance of the pressure decrease on the lee surface in some cases, the pressure decrease contributing three-fourths of the total force in the case of plates at small angles to the wind. At high angles the pressure increase on the front is more important. Cylinders show a large area of pressure decrease. Stream-line bodies show the resultant force not intersecting the body, and the small resultant force to be due to the effect of four distinct forces each of which is large in comparison with the total force.

RALPH W. G. WYCKOFF: *The X-ray diffraction of metallic gallium.* The paper was discussed by Messrs. HUNT, L. H. ADAMS, WHITE, TUCKERMAN, and HUMPHREYS.

Author's abstract: Powder photographs of metallic gallium have been prepared at various temperatures near its melting point (30°C.), but owing to the presence of large crystals they were not perfect photographs. Attempts to assign a cubic structure to gallium on the basis of these limited data failed; this information was insufficient for finding the correct structure with lower symmetry.

The primary purpose of these diffraction measurements, however, was not the determination of atomic arrangement. Metallic potassium at room temperature does not give a crystalline, i.e., a line diffraction pattern with X-rays. Since solid potassium has all the usual physical characteristics of a crystalline material, it seems probable that this general or "amorphous" scattering is to be attributed to the effects of the large amplitudes of the thermal vibrations within the metal rather than to any truly haphazard distribution of its atoms. In view of its low melting temperature, gallium offered a ready means of discovering whether all metals lose their power to give crystalline patterns at temperatures appreciably below their melting points. The photographs of gallium, however, taken at temperatures up to within a degree of this temperature, gave well-marked crystalline diffractions. Though the preceding explanation of the "amorphous" scattering in potassium

may be an incorrect one, it is more likely that the low amplitudes of thermal vibration existing in crystalline gallium at temperatures near to 30°C. are to be attributed to the existence of some sort of molecular groupings. If such is the case, then not only would the thermal energy be distributed between the atoms and the molecules as a whole but the weaker forces operating between the molecules would correspond to a melting temperature lower than would be expected from the same atoms in an ionic grouping (like potassium). This picture of metallic gallium finds experimental support to the extent that the failure of gallium to crystallize in the cubic system (or in the hexagonal closest-packed arrangement) implies that some of its atoms must be more intimately associated together than they are to other nearby atoms.

It is planned to pursue further the question of the effect of temperature upon the X-ray diffraction phenomena from crystals in the neighborhood of their melting points.

W. J. Peters: *Approximate astronomical locations around a base station by use of wireless.*

Author's abstract: The method requires a prearranged program according to which the base station broadcasts altitudes of selected stars, or the sun actually measured at the instants of distinctive signals sent out in groups for each star, or for the sun in groups several hours apart. At the secondary station of which the geographic position is required, altitudes are measured simultaneously with the base station. The differences of the simultaneous altitudes thus measured at the two stations may be plotted on any convenient scale with angles between them equal to the horizontal angles, between the stars observed, or between the positions of the sun in the various groups. The intersection of the perpendiculars erected at the ends of the plotted differences, or the Sumner lines, fixes the relative position of the base station. If the object is merely to find the way to the base station, the plotting may be done upon the ground without the use of drafting instruments by laying off the directions on any convenient scale towards the stars observed. No further computations are required before observations are repeated at some new station or camp nearer to the base station.

In this method there are no data required from the ephemeris; there are no entries to be made in navigational or logarithmic tables; nor are chronometer rates and corrections to be computed. The method has limitations as well as possibilities of application.

J. P. Ault, *Recording Secretary.*

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 14 March 19, 1924 No. 6

CHEMISTRY.—*Life without oxygen.*[1] W. Mansfield Clark, Hygienic Laboratory.

In these days of overcrowded programs an investigator is given but one opportunity to read an essay. That is when his fellows, having retired him from their highest office, display their kindness, letting him down easily with assurances that they really wish a presidential address. It is assumed that a presidential address shall be more of the nature of an essay than a technical paper. Therefore I shall not expand the technical details of the studies on oxidation-reduction which you gave me an opportunity to outline last year, but shall discuss a subject of more popular interest toward the solution of which these technical studies can contribute.

Famine, religious fastings, and the hunger strikes of political prisoners have left records of men living without food for months. Tales of the sea, founded upon fact, have repeated the cry of the Ancient Mariner as day after day he fought thirst with "Water, water, everywhere, nor any drop to drink." To be without food and water for a few days is no great hardship according to the testimony of Stefánsson, but in contrast to this endurance of hunger and thirst is our incessant demand for oxygen.

In every physiological laboratory there is performed an experiment in which the subject rebreathes from a bag. Within a short time the oxygen in the bag is exhausted and to the satisfaction of the instructor and the delight of the students the subject faints. Haldane says that if the residual oxygen in the lungs be washed out with hydrogen, unconsciousness follows in 50 seconds.

[1] Presidential address, presented before the Chemical Society of Washington, January 11, 1924. Published by permission of the Director of the Hygienic Laboratory.

The sailor in his thirst cannot use the water of the sea because its partial pressure is too low for his physiology. A rough parallel is found in the experience of the balloonist. When he reaches high altitudes he finds oxygen still in unlimited quantity but at a partial pressure far too low. Witness the famous balloon ascension by Crocé-Spinelli, Sivel, and Tissander in 1875. At 24,600 feet with the barometer at 300 mm. Sivel obtained the consent of his companions to go higher. He unloaded ballast. They were provided with small supplies of oxygen but Tissander found his arms already paralyzed and could not take the mouthpiece of the oxygen bag. He saw the barometer pass 280 and then became unconscious. He later woke to find they were descending, and, with the cheerful optimism and self-confidence so dangerous in victims of anoxemia, he let go ballast and up they went again. Then the others woke and let go ballast. To all three came unconsciousness. When on the descent Tissander came to, he found both his companions dead. Their supplies of concentrated oxygen had been too small in the first place but they had become partly paralyzed before trying to use it.

The annals of adventure, war, murder, suicide, and persecution describe various crude or artistic methods of producing anoxemia, but a much more fascinating story is the development of an understanding of the manner in which the body supplies itself with oxygen.

In all science there are few developments as beautiful as that which has given us the present precise knowledge of the blood equilibria. There have been found: a quantitative relation between the iron of the blood pigment and the oxygen combining capacity; quantitative data for the equilibria between partial oxygen tensions and degree of oxygen saturation of haemoglobin; preliminary data on the Donnan equilibrium between the oxygen-carrying blood pigment, trapped within the semi-permeable membrane of the red cell, and the plasma; exact relations for the bicarbonate equilibria of the plasma and the acid-base properties of the oxygen carrier; the mechanisms for the maintenance of constant hydrogen ion concentration of the blood and the control of lung ventilation by the activation of a nerve centre called the respiratory centre. Of this Haldane says, "A rise of 0.2 % or 1.5 mm. in the CO_2 pressure of the alveolar air and arterial blood causes an increase of about 100% in the resting alveolar ventilation. The astounding delicacy of the regulation of blood reaction is thus evident. No existing physical or chemical method of discriminating differences in reaction approaches in delicacy the physiological reaction."

Now even ancient man recognized that air was essential to his own vitality. When Joseph Priestley discovered oxygen and Lavoisier named and correctly interpreted its function in the human body the world of thinking men soon came to realize that the life of a man hangs from moment to moment upon his ability to maintain intact the transport of the element oxygen between air and tissues. This is a fact; so are the great achievements in the science of respiration. Is it then any wonder that we who have made our gods in our own image should project this knowledge of our physiology, exclaiming, "There can be no life without oxygen"?

A prominent modern text on physiology opens with the statement, "*All* living things respire—that is they consume oxygen—liberate energy by combustion or oxidative changes, and they give off carbon dioxide." Because of that little word *all* every phrase of this statement is subject to challenge by the records of the literature.

The allegation of universal liberation of energy by combustion and production of carbon dioxide can be disposed of in a sentence. There are organisms which produce active metabolism without liberating CO_2, and there are CO_2 productions which have no relation to the consumption of molecular oxygen. To speak of CO_2 production as necessarily associated with respiration, as Osterhout does, is needlessly to confuse the whole subject by thoughtless definition.

As to the implied dependence on oxygen here are a few facts. As early as 1776 Spallanzani recorded organisms living under greatly diminished air pressure. Miall, in his *Natural history of aquatic insects*, remarks, "Either the storage capacity for oxygen in *Chironomus* larva is considerable or it must be used carefully, for the animal can subsist long without a fresh supply." A study of this problem was made by Leitch, who concluded from laboratory experiments that the storage capacity of the haemoglobin in the *Chironomus* larva is sufficient for at most 12 minutes of anaerobic life. The oxyhaemoglobin is quickly reduced in the mud where the organism is found. Cole confirms this by laboratory and field studies.

As we descend the scale of organized life we find adaptation to anaerobic conditions—that is, life without air—becoming more easy. Protozoa are found in stagnant waters and are parasites in the intestine where conditions are often anaerobic. Pütter kept *Opalina* alive for 20 days in a solution devoid of oxygen. *Opalina* is a genus found in the intestine of the frog. *Balantidium coli* is a closely related protozoon found in the intestine of man, where it and the tape worm must live an anaerobic life. Pütter, having investigated several other

protozoa, says, "Their widespread independence of free oxygen presents a close analogy to countless plants." Pütter kept starved leeches alive 15 days without air, and Bunge cultivated the vinegar eel, which we have all seen wiggling in corked bottles of vinegar, under laboratory conditions seven days without oxygen. In short, there is in laboratory experiments abundant evidence of anaerobiosis, even aside from plant life.

By reason of a fundamental ignorance of cultural conditions laboratory experiments are not entirely satisfactory for long continued experiments. It is, therefore, significant that anaerobiosis has been found under natural conditions.

Juday has reviewed the work on the lakes of Wisconsin, many of which undergo stratification at certain seasons, leaving the bottom water stagnant. Into this bottom water drop decaying materials which reduce the oxygen content so thoroughly that no trace of oxygen has been detected, either by direct gasometric analysis or by two titration methods. In mud taken from the bottom of Lake Mendota, at the University of Wisconsin, 11 genera of protozoa—in form perfectly normal—have been found in abundance. Three species of worms, a rotifer, one species of the crustacea, and one of the mollusca were found. This population was as abundant and as active in late September as in early October, that is, throughout the period of oxygen-lack; and to check against the possibility of temporary migrations from the mud into the upper surface layers of the lake, Juday collected the mud under anaerobic conditions, and observed the organisms in the laboratory. They remained active out of contact with oxygen.

Among the lower orders of true animals and among the protozoa it is evident that there can be anaerobiosis. Let us now turn to a more familiar field.

In 1861, Louis Pasteur read a paper before the French Academy, entitled *Little animals living in the absence of oxygen and bringing about fermentation.* It was a straightforward statement of observation. Organisms we now know as butyric acid bacilli were found moving actively and fermenting in cultures devoid of oxygen. Furthermore the entrance of oxygen stopped their movement and checked the fermentation.

Since this observation there have come to be known as anaerobes numerous bacteria, some of which are our friends and some of which are our deadly enemies. Since these bacteria display most clearly

the fact of anaerobiosis it is interesting to examine the methods of anaerobic culture.

There have been published at least 35 devices, making use of the replacement of air by hydrogen. As a substitute for hydrogen, CO_2, CO, coal gas, acetylene, steam, nitrogen, and argon have been used. At least 7 devices for absorbing oxygen within the medium, and 10 without the medium, exclusive of 41 devices for the use of pyrogallol, have been described. There is no essential difference *in principle* between protecting a culture from access of air by a cover of oil or by a deep layer of the medium, but 20 authors have described deep layers, 7 authors, covers of mica or glass, and numerous authors have tried almost every conceivable oil, and covers varying from agar to plasticine. At least 10 so-called new devices for vacuum cultivation are recorded, and no one knows the number of combinations.

Most of the principles embodied in the various published devices were used by Pasteur and his school, and we must not be deceived by the claims of originality. Rather is it our duty to brush aside the hundreds of papers on the subject and select the few which deal with the principles involved. I shall have time for only a brief review.

In 1877 Gunning, of Amsterdam, expressed his dissatisfaction with the current views of anaerobiosis. He maintained that in no case where bacteria had been observed to grow in what was alleged to be the complete absence of oxygen had adequate tests for the absence of oxygen been applied. Gunning mentioned the possibility of oxygen remaining loosely combined with the materials of ordinary media, the layer of condensed gas formed on glass surfaces, and the diffusion of oxygen through rubber and other connecting material. He reviewed some of the tests for oxygen which had been applied, gave evidence of their inadequacy, and took the stand that the best one can do is to rest on the statement that the method employed has given such and such evidence of low oxygen content—never that the total absence of oxygen has been insured. With ferro ferrocyanid Gunning obtained a reaction for oxygen in boiled water. For the absorption of dissolved oxygen he employed alkaline sugar and ferrous salt solutions, and applying his reagent to the sealed space above the medium, from which he had removed all the oxygen he could, he found no coloration. This indicated that he had obtained more complete removal of oxygen, with better assurance of the fact, than had those who employed the ordinary methods of anaerobic culture. Gunning then applied his methods to actual cultural inves-

tigations, and reported that as the removal of oxygen was made more and more complete the action of bacteria dwindled to almost negligible proportions.

This attack upon the accepted views of bacteriologists drew the fire of Nencki, who emphasized the fact that Gunning had worked with mixed cultures and had taken no care to insure the presence of true anaerobes. Such a retort, while suggestive, did not constitute an adequate reply to Gunning's experimental facts or to the essential theoretical point of his discussion. It gave an opportunity for a vigorous rejoinder, and Gunning seized the occasion for a very clear restatement of his observations. In this he even went so far as to say that, by sufficient removal of oxygen, food can be preserved without heat treatment. Needless to say, this proposal has never proved practicable.

Some years later Lachowicz and Necki continued the controversy by repeating Gunning's experiments with cultures of anaerobes and with attention to the specific points which Gunning had emphasized, using Gunning's reagent. They displaced the oxygen in their apparatus with a stream of hydrogen which did not color this reagent. The inoculation with a "strict anaerobe" was made through an opening through which a stream of this hydrogen was flowing. The products of fermentation were determined as proof that an extensive decomposition had occurred. The bacteriological examination showed abundant growth. If it be granted that the technique was good, the results of Lachowicz and Necki might be regarded as an adequate answer to Gunning. But throughout the history of the subject investigators have repeatedly given out statements essentially similar to Gunning's and based only upon an inherent tendency to demand that all life be supplied with molecular oxygen.

Among the subsequent investigations those of Fermi and Bassu were the most elaborate. But as Gunning had erred on the bacteriological side so Fermi and Bassu erred on the chemical side, displaying an abominable sense of chemical technique. Kürsteiner could not confirm them.

Finally Beijerinck made one of those delightfully *naïve* postulates that recur throughout the history of the subject. He said there can be no strict anaerobes, for every cell has its oxygen requirement, and this requirement is sometimes so small that it cannot be detected by the most refined chemical methods. Such a thesis is easy to defend because by definition it cannot be controverted by experiment.

But to be fair to Beijerinck we must briefly mention the important experimental basis of his deduction. He grew bacteria with limited oxygen supply, and found the so-called respiration figures of Englemann. So-called aerobes congregated nearest the oxygen supply; so-called anaerobes congregated furthest from the oxygen supply. But as the oxygen supply was lowered the so-called anaerobes migrated to a position intermediate between the most and the least oxygenated points. Fox obtained similar so-called respiration figures with a protozoon. Beijerinck also claimed to have shown that short exposure to oxygen is necessary for revivifying certain so-called anaerobic and facultative organisms. He therefore divided bacteria into aerophils—lovers of oxygen—and microaerophils—lovers of little oxygen. This philosophy permeates much of the subsequent literature and with results which are often amusing. A prominent pathologist uses the self contradictory term, "Aerotrophic anaerobe," and a bacteriologist writes, "*Clostridium welchii* is an obligate anaerobe which requires strict anaerobiosis for growth. All anaerobes, especially obligate anaerobes, have an optimum O_2 tension above which growth ceases."

Kürsteiner did not explain the respiration figures of Beijerinck but he did show rather conclusively that certain anaerobes can be carried through 16 inoculations involving numerous generations, all under anaerobic conditions and without impairment of function. For the assurance of the absence of oxygen in these experiments Kürsteiner used the luminescence of the luminescent bacteria. More recently Harvey has shown that the luminescence of these bacteria reveals the presence of one part of oxygen in 3,700,000,000 parts of water. There is now little doubt that bacteria as well as higher forms of life can grow without free oxygen.

In a paper published in 1911, Carl Snyder summarized much of the material I have so far mentioned, and set forth numerous reasons for the belief that the beginnings of life on our planet were anaerobic. Snyder reviews the arguments of Koene, Phipson, Lemberg, Stevenson, Lord Kelvin, and Arrhenius to the effect that our primitive atmosphere was devoid of free oxygen and that the oxygen we now find is that liberated from carbon dioxide by the action of that great plant life which laid down enormous deposits of coal. This plant life was anaerobic and depended for its energy upon sunlight; but with the development of an oxygen atmosphere there arose organisms feeding basically upon plant life, and taking advantage of the energy derived by combustion.

We are not concerned with Snyder's thesis, but rather with the experimental facts as we know them; and now let us return to our own metabolism.

In the introduction I mentioned the blood equilibrium, and the conditions under which oxygen is transported in the blood. What is the destiny of this oxygen in the working muscle?

In their Croonian Lecture, Fletcher and Hopkins made it clear that if the hydrogen ion concentration is maintained at a favorable point and if the products of activity are washed away, a muscle will continue to contract on stimulation in an atmosphere of nitrogen. Fundamentally the process is anaerobic. More recently A. V. Hill, by designing special galvanometers and special thermocouples capable of quickly responding to a rise of one-millionth of a degree Centigrade, has shown that when a muscle is excited by a short shock the immediate mechanical response is followed by a long period of heat production. This heat is due to an oxygen consumption. This oxidation Meyerhof has shown to be associated with a reconstruction of glycogen. It should be especially noted that it is a recovery process of comparative slowness and that the mechanical contraction is an anaerobic phase.

And so at last we have come to see in the muscle itself, that organ which we have always associated with an insistent oxygen demand, the primary anaerobic life displayed in purer form by the anaerobic bacteria.

Some 60 years ago Pasteur conceived of anaerobic and aerobic life as different manifestations of the elasticity of the cell in adapting itself to different conditions. But, because other problems were uppermost in men's minds, and chiefly because of the psychological tendency to extend our own external requirements to a dogma covering all life, the philosophy of anaerobiosis has had hard sledding.

In the arguments of those who insist upon the necessity of molecular oxygen are many fallacies. Undoubtedly the outstanding fault is psychological. This tendency of ours to dogmatize on our own requirements was characterized by Gautier as the great error of physiology. Writers have postulated oxygen reserves in so-called inogen molecules to account for growth without free oxygen. Winterstein has shown that there is not one experimental proof of this. Oxidation is postulated as a necessary source of energy, but even Beijerinck had to admit that the available quantity of oxygen is often too small to have any significance for energy supply, and he ascribed to it a function comparable with that of our present day

vitamines. In doing so he dwelt upon the fact that yeast seems to require rejuvenation by oxygen. Burri claims, with how much justification I do not know, that this is because oxygen is necessary to the yeast for zymase production, and has no general significance. When the zymase is once formed the yeast can live without air.

Sometimes the need of oxygen is postulated with such assurance that writers have said anaerobes tear oxygen from molecular combination and use it in combustion. Of course this is nonsense, but a much more reasonable postulate, and one difficult to handle, is that of intramolecular oxidation. With the exception of this, most of the discussion, as Duclaux said long ago, is mere guesswork. Lesser adds, "In no other field have theories been built so lightly without one experimental proof."

Let us neglect the futile discussions in the literature and return to experimental fact. We have already noted the efforts of bacteriologists to reduce the oxygen tension of the medium. Sometimes, however, oxygen absorbing agents of strictly chemical nature have been used in the culture media themselves. Whether consciously with this purpose, or not, various bacteriologists, at various times and independently, introduced living tissues which are known to absorb oxygen. One used a piece of liver, another a potato, another a germinating seed. When this was done the medium could be exposed to air and still the anaerobe would grow. Now these methods were regarded as new by their authors but in principle they differ in no essential respect from the principle discovered at the very first by Pasteur. He had wondered how anaerobes could exist in a world where oxygen tends to penetrate the habitat of every organism, and he had found a simple answer. In nature are mixed cultures of aerobes and anaerobes. The aerobes exhaust the oxygen and then the latent anaerobes develop. It is believed that the deadly anaerobe of tetanus cannot develop in a wound till aerobes have reduced the oxygen. So efficient is this effect of aerobes that Kedrowski claimed he found anaerobes growing in admixture with aerobes, even though air was bubbled through the culture. This experiment should be repeated because it is pregnant with significance.

Now it is a curious and significant fact that after all the laborious efforts to obtain anaerobic conditions mechanically or chemically and the observation that oxygen is definitely toxic to certain anaerobes, these organisms were found to be able to grow alone in certain simple media when exposed to the air if given an initial start. It was found that inert material such as asbestos, providing shelters in its inter-

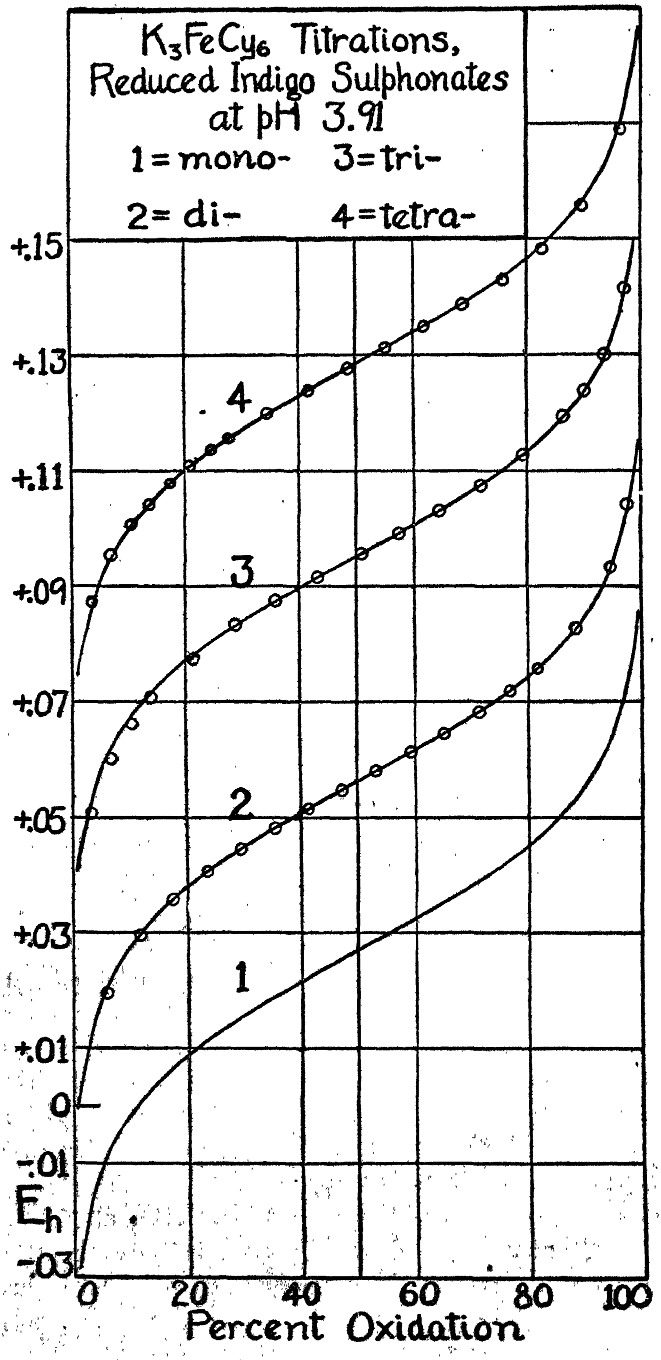


Fig. 1.—Change in electrode potential with oxidation of reduced indigo sulphonates.

stices, favored growth. There can be little question that this is due in part to the native ability of anaerobes to reduce their environment, and thus create their own anaerobiosis if not overtaxed.

In short, we are now tracing a profound similarity in principle among the diverse methods for anaerobiosis. First, there are methods for the mechanical removal of molecular oxygen; second, the chemical absorption of what is presumed to be molecular oxygen within the medium. Both prove the possibility of life without molecular oxygen. But finally we find the positive reducing action of the anaerobes themselves, and are led to believe that if this is not overtaxed anaerobes can produce their own anaerobiosis. Were the older methods after all merely assurances against overtaxing the reducing action of the anaerobes, and what is the significance of this reducing action? In the answer we shall find a new outlook upon many important problems.

From the time when Helmholtz demonstrated the reduction of litmus by bacteria there has been an immense amount work on biochemical reduction which I shall have no time to review. Various organs of plants and animals and the cells of the microscopic world, when isolated from the reversing effect of the oxygen amidst which our ordinary experimental work is done, tend to reduce with a decisiveness which has astonished many an investigator. In studies of this reducing tendency the tools of investigation have been mostly reducible dyes such as indigo carmine and methylene blue. Although the reduction of methylene blue by cells has been found almost universally and hence has been proposed as a test of life, there has been little understanding of the quantitative aspects of dye reduction and consequently a large amount of bizarre speculation.

We now know in terms of electrical potential the intensity conditions governing the reduction of these indicators of reduction.

I reported last year the work on this problem done in the Dairy Division and in the Hygienic Laboratory and shall review the data in the briefest possible way. A mixture of indigo carmine and leuco indigo carmine at constant hydrogen ion concentration (expressed in units of pH) gives a definite electrode potential difference. Graphically expressed (see figure 1), with electrode potential difference as ordinate and percentage reduction as abscissa, we have an $\int$-curve, the mid-point of which gives the characteristic of the system. The different sulphonates lie at different levels as shown in figure 1. Because reduction creates anions the system is sensitive to the hydrogen ion concentration of the solution. If we deal with the mid-point of

each curve as characteristic and carry this 50-50 mixture of oxidant and reductant to different values of pH, we shall obtain the positions of the system in a third dimension, that of pH. Figure 2 shows the experimental result. In short, we have experimentally determined

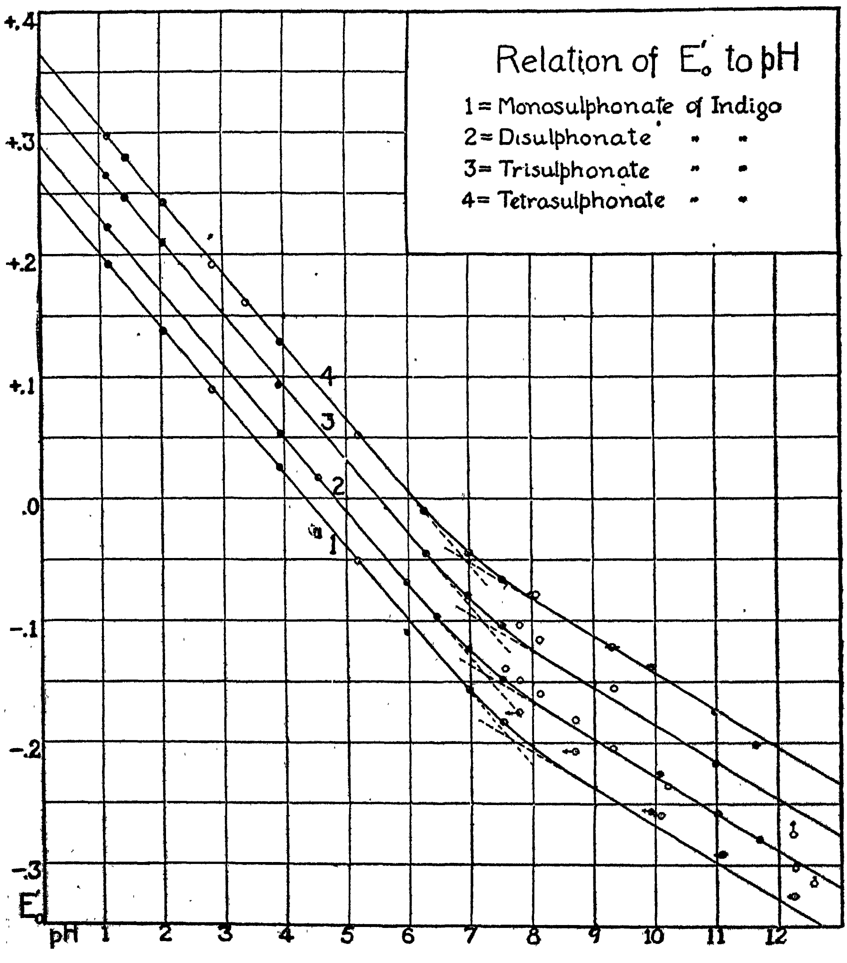


Fig. 2.—Relation of oxidation potential to pH for indigo sulphonates.

the reduction potentials or intensity conditions for the reduction of indigo carmine to any percentage reduction at any pH.

Let us now turn back to a scene in the French Academy on July 1, 1878. On that day Gunning presented his arguments against anaerobiosis. At the close of his remarks Pasteur rose to say that for 16 years he had been seriously concerned with the sources of error

noted by Gunning, and had concluded that his own cultures were free of molecular oxygen because indigo white remained reduced.

This statement we can now interpret. In aqueous solutions electrode potential differences such as those of the indigo system can be interpreted in terms of the oxyhydrogen gas cell. Now in figure 3 electrode potential differences are plotted as lower abscissa and pH values as ordinate. Assuming the potential difference at zero pH and one atmosphere, H_2, as an arbitrary zero point, the slanting line at the left on the chart, represents the variation with change of pH in the potential of a hydrogen electrode. The theoretical potential difference at an electrode under one atmosphere pressure of oxygen

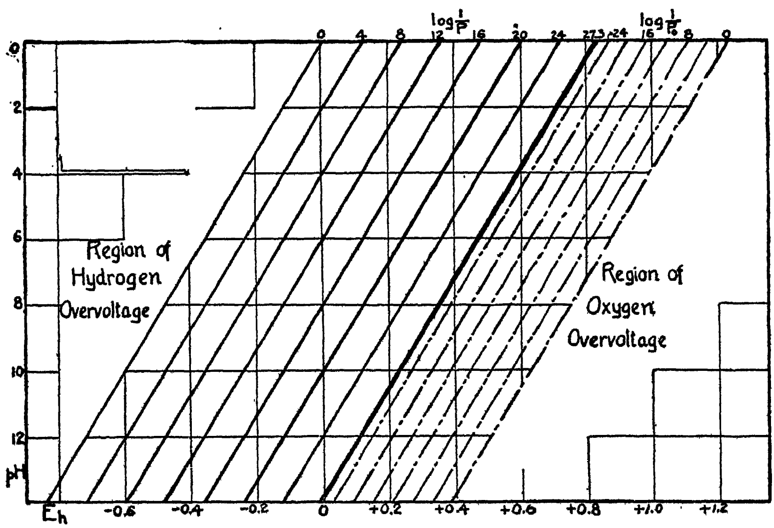


Fig. 3.—Relation of electrode potential to pH for systems of varying degree of oxidation.

is 1.23 volt more positive at all values of pH. The line of the oxygen electrode is, therefore, at the extreme right, parallel to the line of the hydrogen electrode with a constant difference of 1.23 volt between.

The intermediate lines show the relations for diminished hydrogen pressures on the one hand and diminished oxygen pressures on the other hand, at intervals of the 4th power of ten. Knowing the potential difference in terms of a hydrogen electrode and the pH, we can calculate for a partially reduced indigo solution the *hypothetical* hydrogen or oxygen pressures in equilibrium with the system. In a case where we allowed bacterial reduction of indigo carmine to proceed to 80 per cent reduction we measured the potential electrometrically

and calculated therefrom the oxygen pressure. It came out 10^{-36} atmospheric. Taking the data of Millikan on the number of molecules per gram mol of gas we calculate that less than one discrete individual molecule of oxygen was present *at equilibrium* in 10^{13} liters of the culture. To speak colloquially, that is *some* anaerobiosis.

Let it be carefully noted that this conclusion only says that there can be no appreciable oxygen in *equilibrium* with a reduced indigo solution. It does not say that oxygen, because of its inertness, may not remain if originally present. But if present under these circumstances the oxygen must be regarded as comparable to so much inert nitrogen. Even if this is pressing the point too far we must conclude that the reverse situation is impossible, for the thermodynamics of the case will not allow us to generate free oxygen from indigo or even methylene blue. Please note this very carefully in connection with Wieland's finding that the aerobe—the acetic acid organism—can live and function in an oxygen-free medium if provided with methylene blue or quinone. Neither of these can generate free oxygen. Wieland concluded that the action was virtually an oxidation by transport of hydrogen from water to the dye, but it would not be difficult to devise conditions under which this could not take place.

But we can go further. While there is still some doubt regarding the interpretation of certain observed electrode potentials there can be no doubt that certain anaerobic cultures generate a hydrogen over-voltage. It is just such cultures that liberate hydrogen, hydrogen sulphide, and highly reduced products of putrefaction.

It is extremely difficult to conceive of molecular oxygen playing any part in the activity of a cell that is producing a hydrogen over-voltage and tearing to pieces by reductive action materials which resist strong chemical reducing agents.

In short, the earlier debates, concerned as they were with oxygen tensions over the medium, were quite beside the point. The main problem is found in the oxidation-reduction equilibria within the medium. We have seen that life without oxygen is a fact among bacteria, protozoa, and a variety of low animals, but back of all this is an unexplored region.

And now let me ask a question. Are anaerobiosis and aerobiosis two different sorts of life? If they are we shall find difficulty in establishing unity among the myriad of adaptations to both forms of existence. Let it be remembered that the muscle can act in the presence of reduced methylene blue and the anaerobe *tetanus* can

grow in cultures exposed to air. What we find in general is the reducing tendency of the isolated cell; what we find in particular are special mechanisms for the use of molecular oxygen.

And special mechanisms are required, for oxygen is more or less inert. The prairie grass lies bleaching in the sun and dry, the forest leaves wither, our houses stand for centuries when no kindling temperature activates that stable doublet O_2. And life itself, as Meyerhof says, is never in equilibrium with this consuming element oxygen. To use it smoothly, life has evolved its special mechanisms. Beneath these lie more fundamental processes.

We need not detract at all from the true importance of molecular oxygen in the economy of higher organisms. Indeed I emphasized it in the introduction, that we might keep a well proportioned perspective. But in a certain limited sense oxygen can be regarded as a secondary invader, a scavenger, cleaning up the waste products of metabolism by combustion. If for this process the organism develops special mechanisms and seizes upon heat production, seizes upon special oxidations for the restoration of essential materials, seizes upon special oxidation-reduction equilibria for special functions, so much the better. But the importance of these special functions need not blind us to the fact that they may be accessory in much the same sense that iodine is absolutely essential in a special catalytic activity of our own bodies, tryptophane is absolutely essential as a building brick of our own proteins, sugar is essential as a source of our energy, and none of these is essential to certain other organisms.

From this point of view we can approach the study of the cell with an effort to eliminate the complication due to the participation of molecular oxygen. We shall then find a course unreversed by oxygenation.

In presenting this point of view I am conscious of an objection which will at once be raised. Every reduction implies an oxidation in the chemical sense. Granted that the molecular oxygen is absent, *intramolecular* oxidation is still possible. This is true as between specific bodies. Without molecular oxygen alcohol can still be oxidized biologically to acetic acid, and, what is often forgotten, something else must be reduced. But it is not this aspect with which we are concerned. It is simply that, having eliminated the reversing effect of molecular oxygen, we find the inherent ability of the cell to alter a closed system so that the over-all reduction intensity rises higher and higher. Redescription of the reciprocal intramolecular oxida-

tion-reduction between specific bodies does not explain the increase in general reduction intensity of the system.

In your contemplation of this experimental fact I would leave with you but one further conclusion, again based on experimental data. In studying the oxidation-reduction equilibria of dye solutions we find systems that can not be in equilibrium with appreciable quantities of hydrogen or oxygen. Quantitative determinations show that the hydrogens of the same system ionize at different intensity levels. On the other hand there is quantitative evidence proving to the hilt that whatever jumps between reductant and oxidant in the reversible transformation is a pair of electrochemical equivalents, each unit of which jumps between the same intensity levels as the other. There seems to be no interpretation of these experimental facts but the assumption of a direct transfer of an *electron pair*.

If we now examine critically the tests used in the exploration of biological reduction we shall find that they are for the most part colorimetric tests making use of dye-reduction. The solitary conclusion with experimental backing, regarding the mechanism of such reductions by life processes, is that cellular activity forces electrons into these dyes. What is the significance of this to our understanding of life?

As Goethe said, "We are not born to solve the problems of the world, but to find out where a problem begins and then to keep within the limits of our grasp."

The problem I have outlined I leave where the new problem begins. If we knew the answer ours would not be the zest of the pursuit.

BOTANY.—*New West Indian ferns.*[1] WILLIAM R. MAXON, National Museum.

Several collections from the West Indies, chiefly the Greater Antilles, in the last few years have added materially to our knowledge of the fern flora by extending the known range of species previously regarded as confined to one or more of the islands or to continental regions, and by bringing to light a considerable number of new species. Six of the latter are described herewith.

Cyathea brittoniana Maxon, sp. nov.

Caudex erect, 2.5 to 8 meters high; fronds erect-spreading, up to 3 meters long; stipes up to 12 mm. thick at base, ochraceous-olivaceous from a darker base, lustrous, glabrescent, thickly beset with slender straight pungent spines up to 1.5 mm. long, conspicuously paleaceous at base, the scales subulate-attenuate, about 3.5 cm. long, 2 mm. broad at base, rigid, straight, minutely erose-denticulate throughout, golden brown, highly lustrous; blades of an ovate type, abruptly short-acuminate, 2 meters long or more, 1 to 1.2 meters broad, subtripinnate, the rachis ochraceous-olivaceous, aculeolate or muricate, at first closely hirsutulous above, glabrescent, lustrous; pinnae alternate, subdistant, laxly spreading, stalked (1 to 3.5 cm.), linear-oblong, acuminate, 45 to 62 cm. long, 12 to 18 cm. broad, the secondary rachis strigose above, beneath distantly aculeolate or muricate, scantily and laxly hirsutulous, and bearing a few deciduous scales, these linear, up to 9 mm. long, tortuous, fimbriate-ciliate; pinnules 25 to 30 pairs below the tip, distant to approximate, mostly alternate and short-stalked (1 mm.), linear-oblong, 6 to 10 cm. long, 12 to 18 mm. broad, obliquely pinnatifid to about 1 mm. from the costa, the costa densely hirsute-strigose above with curved grayish hairs, beneath thinly hirsute and distantly paleaceous, the scales bright yellow-brown, mostly ovate and long-acuminate, 1 to 2.5 mm. long, slightly concave, asymmetrical or not, thin, lustrous, denticulate-ciliolate; segments 16 to 18 pairs below the tip, oblong, falcate, distally acutish, 3.5 to 4 mm. broad, close, parallel, crenate-serrate (deeply so toward the tip), the costule hispid above, beneath thinly hirsute and bearing a few small scales toward the base, these mostly bullate, bright yellowish brown, thin; veins 8 to 10 pairs, oblique, mostly once forked below the middle, prominulous and glabrous above, thinly hirsute beneath, the hairs extending to the leaf tissue; sori 3 to 5 pairs, small (about 0.7 mm. in diameter), slightly inframedial; indusium globose, membranous, transparent, rupturing irregularly, the divisions subpersistent; receptacle small, short-capitate; paraphyses numerous, short, flattish, flaccid, deciduous. Leaf tissue dull dark green, slightly paler beneath, delicately membranous.

Type in the U. S. National Herbarium, no. 755,722; collected in mountain forest, Mt. Alegrillo, Porto Rico, at 900 meters altitude, April 3, 1913, by N. L. Britton, F. L. Stevens, and W. E. Hess (no. 2620). Other specimens examined are as follows:

PORTO RICO: Maricao, July, 1913, *Hioram* 809.

CUBA: Monte de la Prenda, Oriente, altitude 800 meters, in forest, *Eggers* 5211. Pinal de Santa Ana, Oriente, altitude 800 meters, *Eggers* 5031.

[1] Published by permission of the Secretary of the Smithsonian Institution.

DOMINICAN Republic: Paradis, Barahona Province, at 450 meters altitude, *Abbott* 1590.

TRINIDAD: Without locality, *Fendler* 80 (3 sheets, as *C. schan-schin*). Mt. Tocuche, in forest, *Britton, Hazen & Mendelson* 1351.

Cyathea brittoniana is closely related to *C. tenera* (J. Sm.) Griseb., to which the material above described has been erroneously referred in recent years. That species, described originally from St. Vincent, is widely distributed in the West Indies. It differs from *C. brittoniana* in its darker and more strongly aculeate stipes (the spines fewer, up to 3 mm. long), its dilatate, less falcate, nearly obtuse segments (the sinuses broader), its more numerous bullate scales (these usually extending two-thirds the length of the costule), and its scant hirsutulous rather than hirsute condition beneath, the hairs inconspicuous, much shorter than in *C. brittoniana*, and rarely if ever extending to the leaf tissue. One other character is noted in the paraphyses, which are somewhat rigid, dark castaneous to vinaceous, and subpersistent, in contrast to those of *C. brittoniana*.

The following specimens of *C. tenera* are at hand:

ST. VINCENT: *H. H. Smith* 1717; *H. H. & G. W. Smith* 292; *Eggers* 6859.

GRENADA: *Elliott* 10; *Murray & Elliott* 10; *Sherring* 157, 228 (4 sheets).

MARTINIQUE: *Sieber* 374.

MARGARITA ISLAND (Venezuela): *Johnston* 143 (2 sheets).

TRINIDAD: Heights of Aripo, *Broadway* 9968 (2 sheets). Morne Bleu, *Britton, Freeman & Bailey* 2285.

CUBA: Loma San Juan, Sierra Maestra, altitude 1,050 meters, *Léon, Clement & Roca* 10535.

DOMINICAN REPUBLIC: Paradis, Barahona Province, altitude 600 meters, *Abbott* 1664.

Polypodium oxypholis Maxon, sp. nov.

Rhizome wide-creeping (15 cm. or more), 1 to 2 mm. in diameter, sinuous, green, emitting a few radicose rootlets at intervals, densely paleaceous at the growing tip (2 to 5 cm.), subpersistently so throughout, the scales dark brown, divaricate, 5 to 6 mm. long, evenly linear-attenuate from a deltoid-lanceolate deeply auriculate base, attached at the distant included sinus, rigid, subdentate, clathrate, the cells of the elongate portion narrowly oblong to linear-polygonal, with strongly sclerotic yellowish-brown partition walls, the outer walls thin and translucent. Fronds several, 1 to 2.5 cm. apart, 30 to 35 cm. long, ascending; phyllopodia small, 1.5 mm. high; stipes 11 to 17 cm. long, very slender (0.5 to 1 mm. thick), stramineous, naked; blades 17 to 22 cm. long, 2 to 3.5 cm. broad at middle, simple, varying from narrowly oblong-lanceolate to pointed-linear, long-acuminate or attenuate at base, caudate at apex (the tip about 3 cm. long, 5 mm. broad at base), repand, the margins unevenly sinuate; costa greenish-stramineous, elevated on both surfaces, 0.5 mm. broad or less; main veins 25 to 35 pairs, mostly alternate, diverging from the costa at an angle of 45° to 50°, elevated beneath nearly to the margin, flexuous, the connecting veins strongly arcuate; areoles mostly arranged in 4 series from costa to margin, variable in shape, size, and venation, the costal ones in the middle portion of the blade mostly obovate-cuneate, with a single included fertile veinlet; second and third areoles broader,

with 1 or 2 short included fertile veinlets, or one or both of these excurrent to the next cross-vein, or the areole divided by a median excurrent veinlet, the marginal areoles commonly so divided; sori in 4 irregular incomplete rows on either side of the costa, appearing sparse; leaf tissue translucent, firmly pergamentaceous, sublustrous, the margins somewhat cartilaginous and narrowly revolute, the veins (primary ones excepted) immersed.

Type in the U. S. National Herbarium, no. 1,077,311, collected on a damp cliff of Morne de Ouésanne (Morne de Brouet), near Furcy, Haiti, altitude about 1,300 meters, June 13, 1920, by E. C. Leonard (no. 4782).

A peculiar species, without near relatives. In its slender stipes and slight, wide-creeping, divaricately paleaceous rhizomes only it suggests *P. vulpinum* Lindm.[2] a species which differs widely in its much smaller size, in shape of blade and in most details of venation, and in its rhizome scales, these thin, ferruginous, concolorus, and nonclathrate, the cells with all the walls thin and nonsclerotic. The relationship with *P. vexatum* D. C. Eaton is remote, that species having the rhizome short-creeping and much stouter (3 to 8 mm. thick), the rhizome scales thin, *orbicular-ovate, peltate,* and *closely appressed* to the rhizome, and the blades very strongly long-attenuate downward to the narrowly alate stipe. On the basis of scale characters alone the species may be distinguished at a glance.

Stenochlaena amydrophlebia Slosson, sp. nov.

Rhizome flat, woody, 12 mm. broad, densely paleaceous at the produced tip, the scales bright russet brown, lance-attenuate, 6 to 9 mm. long, about 1.5 mm. broad, very lax, membranous, denticulate and bearing very long filament-like gland-tipped teeth. Sterile frond 70 cm. long; stipe 25 cm. long, dull brown, finely paleaceous in the basal part; blade lance-oblong, obtuse, 45 cm. long, 14 cm. broad near the middle, pinnate, the rachis strongly foliaceo-marginate; pinnae 16 or 17 on each side, alternate, distant (inserted 2 to 3 cm. apart on each side), linear, 6 to 9 cm. long, 10 to 13 mm. broad, narrowly cuneate at the inequilateral base, rather abruptly short-caudate at apex (the tip 5 to 7 mm. long, 1 to 2 mm. broad, blunt), oblique, straight or subfalcate, subentire or at apex sinuate-dentate, glabrous above; apical pinna conform; midvein broad and obtusely sulcate above, beneath minutely and obscurely paleaceous at the elevated base, a few very minute substellate scales extending to the veins and leaf issue; veins close, slightly oblique, mostly once forked near the base, deeply immersed, concealed above, their course barely evident beneath; leaf tissue coriaceous, dull green above, a little paler or somewhat yellowish green beneath. Fertile frond 63 cm. long; stipe 22 cm. long; blade lanceolate, 41 cm. long, about 10 cm. broad below the middle, the rachis deciduously fibrillose; pinnae about 16 pairs, alternate, distant, oblique, linear, mostly 4 to 7 cm. long, 2 mm. broad, substipitate; spores minutely papillose.

Type in the Underwood Fern Herbarium, New York Botanical Garden, collected in dense forest, Río Icaco and adjacent hills, Sierra de Naguabo, Porto Rico, altitude 465 to 720 meters, July 30 to August 5, 1914, by J. A. Shafer (no. 3510a); fragments are in the U. S. National Herbarium, no.

[2] Described from Brazil and now known from numerous Haitian specimens (Furcy, *Leonard* 4287, 4638, 4721, 4778; Mission, *Leonard* 4010, 4024.

694,686. Other Porto Rican specimens are a sterile unnumbered Sintenis plant, without special locality data, and two juvenile plants collected in the Sierra de Naguabo by Britton and Hess (no. 2294) at an altitude of 950 meters. Received recently also from the Dominican Republic (*Fuertes* 1044c), the specimens fertile and entirely characteristic.

A well marked species, related apparently to *Stenochlaena wrightii* (Mett.) Griseb., of eastern Cuba (*Wright* 787; *Maxon* 4300, 4481; *Shafer* 8833; *Léon, Clement & Roca* 10385; *Hioram & Maurel* 2484; *Pollard & Palmer* 150; *Pollard, Palmer & Palmer* 220). That species, however, differs conspicuously in its sterile fronds, the pinnae (5 to 10 pairs) being obovate to oblong-oblanceolate, 1.5 to 3 cm. broad, and abruptly truncate below the long-caudate apex.

Dryopteris petiolata Maxon, sp. nov.

Subgenus *Goniopteris*. Rhizome woody, decumbent, apparently 5 or 6 cm. long, about 2 cm. thick, densely paleaceous at apex, the scales imbricate-spreading, linear-attenuate, 9 to 11 mm. long, 2 mm. broad at base, bright brown, thin, lustrous, entire, laxly stellate-puberulent. Fronds several, subfasciculate, 65 to 85 cm. long, suberect; stipes 30 to 45 cm. long, stramineous, deeply sulcate at the strongly arcuate darker base, naked, deciduously stellate-pubescent, lustrous; blades lance-oblong, evenly acuminate at tip, scarcely or not at all reduced at base, 35 to 45 cm. long, 15 to 20 cm. broad, pinnate, the rachis similar to the stipe, devoid of simple hairs; pinnae 12 to 15 pairs below the tip, spreading nearly at a right angle, distant, subopposite to alternate, mostly stalked (1 to 3 mm.), the lower ones narrowly linear-lanceolate, those above nearly linear, mostly 8 to 10 cm. long, 12 to 17 mm. broad, all but the upper ones pinnatifid nearly half-way to the costa except at the attenuate subcaudate tips, these 1.5 to 2.5 cm. long, subentire; costae elevated beneath, scantily and deciduously hirsutulous, stramineous, persistently stellate-pubescent, stellate hairs extending also to the prominulous veins and sparingly to the leaf tissue of both surfaces; segments about 18 pairs, slightly oblique, rounded-triangular, mostly a little longer than broad, the margins entire, slightly revolute, beset with numerous short oblique rigid cilia; veins 6 to 8 pairs, simple, close, the basal ones joined, the resultant veinlet and the second or second and third veins excurrent to sinus; sori strongly inframedial, large (nearly 1.5 mm. in diameter), round, close, forming a dense row almost against the costule; indusia minute, detergible, consisting of several connate branched hairs; sporangia very numerous, nonsetose.

Type in the U. S. National Herbarium, no. 1,145,848, collected on steep mountain slope near Liali, Dominican Republic, at 400 to 500 meters altitude, February 9, 1923, by W. L. Abbott (no. 2596). A second specimen of the same number is mounted on sheet no. 1,145,791.

Because of its general leaf-form and stalked pinnae *D. petiolata* is to be compared with *Dryopteris pyramidata* (Fée) Maxon, which also occurs in the eastern part of the Dominican Republic and is not uncommon in the Lesser Antilles southward to the Guianas. That species differs not only in its triangular blades and in having one or several pairs of the lower pinnae reduced at the base, but very materially also in its more oblique and more numerous veins (these usually connivent only), in its freely pilose-hirsute

rachis and costae (similar but minute simple hairs extending to the costules and veins), and in having the sori medial and distinctly indusiate, the indusia small but firm and persistent, with numerous simple marginal hairs. In *D. petiolata* a few simple hairs are found upon the costae, but all other vascular parts (including the rachis) are stellate-pubescent only, the branched hairs coarse and readily seen; whereas in *D. pyramidata* simple hairs predomiate throughout, the stellate pubescence being obscure and exceedingly minute. The indusial characters are equally distinctive.

Dryopteris aripensis C. Chr. & Maxon, sp. nov.

Rhizome not seen; stipe brown, 30 cm. long, 7 mm. thick at base, flexuous, trisulcate above, flattish-angulate, densely paleaceous toward the base the scales linear-attenuate, 7 to 13 mm. long, about 0.3 mm. broad at base, flexuous, denticulate-ciliate, bright cinnamomeous, similar but reduced darker scales extending upward to the rachis; blade ovate-oblong, acuminate, about 70 cm. long, 35 to 40 cm. broad, bipinnate, the rachis villous-pilosulous above with pluricellular hairs, beneath persistently paleaceous, the scales linear-attenuate, dark brown, subentire or distantly denticulate; pinnae about 20 pairs, the lower ones short-stalked (5 mm.), opposite, the others mostly subsessile, alternate, subdistant, all equilateral, linear-oblong, long-acuminate, the third or fourth pair the largest, 18 to 20 cm. long, 4 cm. broad, fully pinnate nearly throughout, the costa densely hirsute above with long oblique flattish white septate hairs, beneath scantily paleaceous, the scales brown, subulate-attenuate, denticulate, spreading; pinnules about 20 pairs, slightly oblique, the largest ones 2 cm. long, 7 to 8 mm. broad, the basal ones sometimes a little shortened, the others subequal, fully adnate and slightly decurrent, oblong, broadly rounded at apex (the smaller ones nearly truncate), straight or subfalcate, crenate-serrate to obliquely lobed one-third the distance to the costule, the lobes about 5 pairs, persistently short-ciliate; costules thinly long-hirsute above (the hairs about 1.5 mm. long, extending freely to the veins), sparsely hirsute beneath; veins 6 to 8 pairs, mostly once-forked, or the larger lobes with 2 pairs of subpinnately arranged branches, not reaching the margin, glabrous beneath; sori 2 or 3 to each group of veinlets, inframedial, nonindusiate. Leaf tissue dark green above, membrano-herbaceous.

Type in the U. S. National Herbarium, no. 1,059,366, collected on the Heights of Aripo, Trinidad, in forest, March 16, 1921, by N. L. Britton and W. G. Freeman (no. 2349). A second sheet of the same number has yielded data as to stipe and basal scales, and there are besides two other collections from the same locality: *Broadway* 9965 and *Britton & Freeman* 2352, these less developed.

Dryopteris aripensis belongs to the subgenus *Ctenitis*, group *Subincisae*, and is nearest related to *D. haitiensis* (Brause) Urban & Maxon,[3] both differing from *D. subincisa* in their small, narrow, bipinnate blades. In *D. aripensis* all the pinnae are narrowly oblong and essentially equilateral, the basal ones sometimes a little shorter than those above; in *D. haitiensis* the middle pinnae are triangular-oblong and nearly equilateral, and the basal pinnae short, triangular, and inequilateral; in *D. subincisa* the basal pinnae

[3] Journ. Wash. Acad. Sci. **14**: 91. 1924.

are much the largest of all, compound, and strongly produced basicopically. From *D. haitiensis* the present species differs in the form of its pinnae, as just mentioned, it its more numerous, close, subequal, less deeply pinnatifid pinnules, in its thin texture, and in numerous details of scale structure and pubescence, the costules and veins of *D. haitiensis*, for example, entirely lacking the numerous, very long, stiff, white, septate hairs characterizing the same parts of *D. aripensis*.

Leptochilus pergamentaceus Maxon, sp. nov.

Plants terrestrial. Rhizome woody, horizontal, creeping, relatively slender (4 to 8 mm. thick), terete or flattish, brown, closely brownish-paleaceous; fronds few, erect, subdistant. Sterile fronds up to 1 meter long or more; stipes about as long as the blades, stout, trisulcate above, stramineous from a darker fibrillose-paleaceous base; blades broadly ovate-oblong, acuminate, 40 to 60 cm. long, 25 to 45 cm. broad, simply pinnate, the rachis stout, stramineous; pinnae mostly 2 to 5 pairs and a large terminal one, alternate, oblique, ovate, lance-ovate, or broadly oblong, acuminate to acuminate-caudate (sometimes abruptly so), mostly inequilateral and subfalcate, somewhat rounded or broadly cuneate at base (the lower ones distinctly stalked), more or less repand, the margins entire or broadly sinuate; lateral veins oblique (55°), decurved at extreme base, falcate, strongly elevated almost to the margin, here upwardly arcuate; transverse veins 8 to 10 pairs, elevated, deeply arcuate; areoles mostly shorter than broad, copiously reticulate, the ultimate meshes numerous, minute, mostly with 1 or 2 free included veinlets; leaf tissue firmly pergamentaceous, glabrous, usually light green, paler beneath. Fertile fronds up to 1 meter long, long-stipitate; pinnae 2 to 4 pairs and a larger terminal one, distant, oblique, lanceolate to narrowly oblong-lanceolate, acuminate, up to 15 cm. long and 4 cm. broad, densely sporangiate, the costae excepted; sporangia glabrous, the annulus 14-celled; spores very broadly and delicately winged.

Type in the U. S. National Herbarium, nos. 521,264 and 521,265, sterile and fertile fronds respectively, collected at Green River Valley, Jamaica, altitude 750 meters, February 11, 1903, by L. M. Underwood (no. 1426). Other specimens at hand are as follows:

JAMAICA: Several localities, *Underwood* 123; *Maxon* 1841, 1951, 2380; *Maxon & Killip* 550, 805; *Hart* 111; *Clute* 283; *A. Moore.*

CUBA: Several localities, *Wright* 788 (4 sheets); *Maxon* 3908, 4164; *Van Hermann* 3203; *Pollard & Palmer* 164; *Britton & Britton* 5002; *Hioram & Maurel* 2444.

PORTO RICO: Several localities, *Sintenis* 6534; *Shafer* 3790; *E. G. Britton* 5217; *Britton, Cowell & Brown* 5258; *Britton, Britton & Brown* 6177.

DOMINICAN REPUBLIC: Laguna, *Abbott* 378. Puerto Frances, *Abbott* 1205. Paradis, *Abbott* 1598. Liali, *Abbott* 2632.

GUATEMALA: Cubilquitz, *Türckheim* (J. D. Smith, no. 8045).

COSTA RICA: Without locality, *Wercklé.*

VENEZUELA: Upper Guaremales, road from Puerto Cabello to San Felipe, *Pittier* 9108.

As a result of recent study of the material passing as *Leptochilus nicotianaefolius* (Swartz) C. Chr. it becomes necessary to recognize two species of close relationship. These were long ago distinguished by Fée[4] as *Gymnopteris*

[4] Mém. Foug. 2: 85, 86. *pl. 46*. 1845.

nicotianaefolia Presl and *G. acuminata* Fée, the latter a transfer of *Acrostichum acuminatum* Willd. (1810), which was founded on a sterile specimen from "Peru" and upon Plumier's illustration of a Martinique plant (*pl. 115*). Unfortunately Fée, following Willdenow and Presl, applied the name *Acrostichum nicotianaefolium* Swartz in a wrong sense. This species had been described from St. Thomas in 1806. The original specimen is an atypical intermediate frond of five pinnae, the terminal pinna and two upon one side being small and fertile, the other two lateral ones large and sterile—an obvious monstrosity, such as occasionally develops in many species with dimorphic fronds. Several photographs of the type have been received from Stockholm through the kindness of Prof. C. A. M. Lindman. Not only in leaf shape but in details of venation these show essential agreement of the St. Thomas plant with Fée's description and illustration of *G. acuminata*, based upon material from Martinique and Guadeloupe and a single specimen from Jamaica. *Gymnopteris acuminata* (Willd.) Presl is thus a synonym of *Leptochilus nicotianaefolius* (Swartz) C. Chr. If regarded as based upon Plumier's plate 115, *Acrostichum acuminatum* Willd. also is synonymous; the identification of the Peruvian specimen cited by Willdenow remains in doubt. The Cuban plant (*Linden* 2117) which Fée describes as *G. nicotianaefolia*, and of which he gives a folio illustration, belongs to the species described above as *L. pergamentaceus*.

The distinctions between the two species are for the most part clear and have been partly stated by Fée. Thus, true *L. nicotianaefolius* (*G. acuminata* Fée) is usually epiphytic, climbing at the base of trees or sometimes on rocks; the pinnae of the sterile fronds are mostly stalked, straight and equilateral, and are usually elliptic-oval or narrowly pointed-oblong, the margins rather strongly sinuate; the lateral veins are less elevated and do not approach close to the margin; the transverse veins are much less deeply arcuate; the ultimate areoles are very much larger, many of them without included veinlets; and the leaf texture is membranous, not pergamentaceous, the ultimate venation prominulous.

Leptochilus nicotianaefolius widely overlaps *L. pergamentaceus* in range. In Jamaica it has been described as *Acrostichum nicotianaefolium* var. *saxicolum* Jenman.[5] The plant that Jenman describes as the typical form of *nicotianaefolium* is *L. pergamentaceus*.

Of *L. nicotianaefolius* the following material is in the National Herbarium:

MARTINIQUE: *Duss* 1699.

GUADELOUPE: *Duss* 4145.

ST. THOMAS: Photographs of the type, *ex herb. Swartz*.

PORTO RICO: Near Mayaguez, *Britton & Marble* 634.

DOMINICAN REPUBLIC: Cotuy, *Abbott* 822. Paradis, *Türckheim* 2822.

JAMAICA: Seamen's Valley, Portland, *Maxon & Killip* 40.

GUATEMALA: Cubilquitz, Alta Verapaz, *Türckheim* (J. D. Smith, no. 8829).

[5] Bull. Bot. Dept. Jamaica, n. s. 5: 153. 1898.

SCIENTIFIC NOTES AND NEWS

The following communication has been received from Dr. David Starr Jordan, Stanford University, California:

"The recent burning of the great Library of the Imperial University of Tokyo (with 500,000 to 700,000 volumes) is in itself a world calamity. I learn that the American Universities, Law Schools, and many City Libraries have given very generously of their publications, and of duplicates. Much has also been received from private sources. The chief deficiencies at present, are in scientific lines: Medicine, Physics, Chemistry, Biology, Mathematics and Engineering. At the request of Japanese friends, I make a special appeal to associations and workers in Science for donations of books and serials of scientific value.

Shipments will be received and transported free at the following addresses: Toyo Kisen Kaisha (T. Komatsu), 557 Market St., San Francisco, Calif; Mr. Aneha, care Hopkins Company, 18 Old Slip, New York City; Nippon Yusen Kaisha, Colman Bldg., Seattle, Wash.; Osaka Shosen Kaisha, Steel Steamship Co., Whitney Bldg., New Orleans, La."

The program for the meeting of the Washington Section of the American Chemical Society held February 14 was as follows: A. L. DAY: *The inter-relation of field and laboratory work.* E. T. ALLEN: *Field methods in the study of volcanology.* R. W. G. WYCKOFF: *Application of X-rays to the study of geophysics.* G. W. MOREY: *Experimental methods for the study of silicates at high temperatures, with demonstration of quenching a silicate melt.*

Dr. A. S. HITCHCOCK, agrostologist of the Department of Agriculture, returned last month from South America. Dr. Hitchcock visited Ecuador, Bolivia, and Peru, making extensive botanical collections.

GERRIT S. MILLER, JR., curator, Division of Mammals, National Museum, left Washington last month for a visit to some of the islands of the Lesser Antilles. Mr. Miller expects to make collections of the flora and fauna of the islands.

W. S. W. KEW, geologist of the U. S. Geological Survey, engaged in the study of the oil fields of Southern California, has resigned to do private work.

The Petrologists' Club met at the home of H. G. Ferguson on February 20. The evening was devoted to a discussion of corundum (crystalline alumina). W. L. BOWEN spoke on *Corundum in silicate melts;* H. INSLEY, on *Artificial contact metamorphic deposits;* and F. E. WRIGHT, on *Corundum in Africa.*

The Pick and Hammer Club met February 23, 1924, at the Geological Survey, addresses being made by speakers from the Carnegie Institution. Program: L. A. BAUER: *The geological bearing of investigations in terrestrial magnetism;* A. L. DAY: *The volcanic action at Lassen Peak;* E. T. ALLEN: *The hot springs at Lassen Peak;* H. S. WASHINGTON: *The chemical constitution of the Earth.*

A series of three lectures entitled *Some high lights of visual psycho-physics* will be given at the Physics Club of the Bureau of Standards by I. G. PRIEST in the Chemistry Building, at 4:30, as follows: March 24, *The classification and nomenclature of colors;* March 31, *general review of the leading principles of visual psycho-physics;* April 7, *Equivalent stimuli and relations deduced from the laws of mixture of stimuli.*

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 APRIL 4, 1924 No. 7

PHYSICS.—*Determination of thermal conductivity of refractories.*[1]

MAYO D. HERSEY and EDWARD W. BUTZLER, Bureau of Mines.

Introduction. This paper contains (1) a brief account of thermal conductivity work in progress at the Pittsburgh Experiment Station, U. S. Bureau of Mines; (2) discussion of a suggested formula to correct for transverse heat leakage and departure from a steady state; (3) numerical results up to a maximum temperature of 945°C.

Many investigations of mineral products, especially refractories, require a knowledge of thermal conductivity at high temperatures. Apparatus was designed for this purpose by G. R. Greenslade early in 1922 and later turned over to the present writers for further development. Our first tests above 900°C. were completed in December, 1923, and a report[2] submitted for publication at that time which may be consulted for additional details.

Apparatus. Heat flows outward in both directions from a flat central heater as in the low temperature apparatus of the Bureau of Standards, and it is caused to flow along paths perpendicular to the surfaces of the two samples under test by means of guard-heaters suitably regulated. In order, however, to raise the temperature of the cooler surface of the sample material to within say 100 deg. C. of the temperature of the hotter surface, a requirement peculiar to the high-temperature problem, it is necessary to provide end heaters

[1] Published by permission of the Director, Bureau of Mines, Department of the Interior. Received February 19, 1924.

[2] *Conductivity and specific heat of refractories at high temperatures.* By M. D. Hersey and E. W. Butzler. Reports of Investigations, Bureau of Mines, Department of the Interior, Serial No. 2564.

and guard rings, making six heating elements in all. The heat input is measured electrically, and, as a check to detect escape of heat sideways before passing completely through the sample, the original Greenslade design provided very thick iron plates adjacent to the outer surfaces of the two layers of brick under test. If sufficiently accurate measurements of temperature drop through these iron plates can be made, we have a direct measure of the heat outflow, which should agree with the electrical heat input if there is no transverse flow of heat through the bricks.

This check measurement has been omitted by the present writers and the necessary result arrived at in another way as explained below. Other minor modifications were made in completing the construction of the apparatus.

The testing unit thus consists of three flat heaters and guard rings wound with nichrome wire, two layers of brick under test (about two inches thick and one foot square), and four thin metal plates with guard rings (the two plates nearest the central heater being of nickel), beside the two thick iron plates that are not being used. These various layers are cemented together one on top of the other and surrounded on four sides with a very thick layer of silocel bricks. The two end heaters are also, during high temperature tests, protected by a layer of silocel of adjustable thickness.

As finally assembled the apparatus comprises about 18 thermocouple circuits for measuring the various temperature drops, including differential couples for guard ring regulation, and these are connected to a Tinsley vernier potentiometer reading to one microvolt. Three thermo-junctions are installed in each layer of brick under test. Two of these are cemented into grooves close to the respective surfaces for observation of temperature drop during conductivity tests, while the third is an interior junction (half way between the two surfaces) for reference in checking heat flow measurements and in computing the relative specific heat of successive materials from observations on the rate of heating.

The heat input and guard ring control comprises six heavy current circuits connected through water-cooled rheostats to storage battery and alternating current sources.

Observations. After reaching a nearly steady state (which may require over 24 hours) and balancing the guard-heaters so as to insure a flow of heat approximately perpendicular to the surfaces of the brick, the apparatus is ready for final observations. The following

are recorded from time to time: (1) ammeter and voltmeter readings for the central heater, from which to compute $2H$, the total heat input in calories per second; (2) thermocouple readings in microvolts from which to compute three different brick temperatures, viz. the average hot surface temperature t_1, the average temperature at the cooler surface t_2, and the average temperature t_m at the midpoint. In addition the following constants for the apparatus must be known: (1) exact distance between the planes containing the various hot-junctions of the couples by which the brick temperatures t_1, t_2, and t_m are observed; (2) effective area, A, covered by heater wire through which the voltage drop used in computing heat input ($2H$) takes place; (3) calibration data for thermocouples, and other instruments, over the working range.

Computation of conductivity. From the definition of thermal conductivity, k, we have

$$k = \frac{H}{AG} \tag{1}$$

where H is the heat flow (e.g. calories per second) through area A, and G the corresponding temperature gradient. It has been customary to take for G the over-all gradient, which may here be denoted by G_o, i.e.,

$$G_o = \frac{t_1 - t_2}{x} \tag{2}$$

where x is the thickness of the layer of brick comprised between the two isothermal planes t_1 and t_2. But, when G_o is taken for G, it is necessary to use for H the corresponding heat flow H_o averaged from input and outflow observations at the respective surfaces, except in the ideal case when there is no transverse heat leakage at all, and no accumulation of heat within the brick.

On account of the high temperature of the cooler surface of the brick in the present experiments it seemed impracticable to use any flow-calorimeter method for direct measurement of heat outflow, or even to utilize the temperature drop through some low-conductivity material. For these outflow observations would not be of any genuine help unless comparable in accuracy with that of the heat input observations, or, at least, with the accuracy of determination of the thickness factor x.

Considering the above difficulties, our proposed method for applying Eq. (1) has been simply to use for G, not the over-all gradient,

but the actual temperature gradient at the hot surface where H is observed. This can not be directly measured, of course, but it may be computed in terms of the over-all gradient G_o by the relation

$$G = G_o(1 + dG/G_o) \qquad (3)$$

where the gradient correction is given by

$$\frac{dG}{G_o} = 4\left(\frac{t - t_m}{t_1 - t_2}\right) \qquad (4)$$

As defined already, t_1 denotes the temperature of the junction near the hotter surface of the brick, t_2 near the cooler surface, t represents the mean temperature of the brick $(t_1 + t_2)/2$; and t_m is the observed temperature in the interior of the brick at a distance just midway between t_1 and t_2.

The proof of (4) will readily be apparent by constructing a diagram with ordinates t_1, t_m, and t_2 erected at distances 0, $x/2$, and x from the hot surface, together with a second diagram having ordinates G, $\frac{t_1 - t_m}{x/2}$, and $\frac{t_m - t_2}{x/2}$ erected at distances 0, $x/4$, and $3x/4$ from the hot surface. In effect, G is an extrapolated value derived from two observed gradients, namely those corresponding to the hotter and colder halves of the brick respectively.

Experimental results. The following data from six independent tests on Hytex hydraulic pressed building brick, and on Central of Georgia firebrick (G–3) will indicate the degree of consistency secured by the application of the correction factor in Eq. (4) above. In this table the apparent conductivity values k_a, corresponding to the mean temperatures t, were computed from Eq. (1) by substituting numerical values of G_o where G occurs in the formula, a procedure that would be correct only when there is a steady state and no escape of heat sideways from the brick under test. The true conductivities k corresponding to the temperatures t_1 were computed by reference to Eq. (4).

The values in the last column show a consistent increase of conductivity with rising temperature. Samples have been saved for check determinations in the future by other methods or by other laboratories. In the meantime the apparatus is being futher improved for routine use.

This investigation was undertaken by G. R. Greenslade and F. A. Hartgen on the initiative of John Blizard, formerly Fuels Engineer, Bureau of Mines. It has been continued under the direction of A. C. Fieldner, Superintendent, Pittsburgh Experiment Station, and

in cooperation with G. A. Bole, Superintendent, Ceramics Experiment Station, Bureau of Mines, Columbus, Ohio. The writers are indebted for valuable suggestions or information to Messrs. C. M.

TABLE 1.—THERMAL CONDUCTIVITY RESULTS

BRICK	APPARENT CONDUCTIVITY		GRADIENT CORRECTION	TRUE CONDUCTIVITY	
	t	k_a	$\frac{dG}{G}$	t_1	k
	°C.	c.g.s.	per cent	°C.	c.g.s.
Hytex	140	0.00289	+5.0	155	0.0028
	155	0.00280	−2.8	175	0.0029
	225	0.00280	−4.2	260	0.0029
Georgia	245	0.00219	+13.2	290	0.0019
	370	0.00215	+13.6	450	0.0019
	910	0.00309	+16.0	945	0.0027

Bouton and W. E. Rice of the Bureau of Mines; H. C. Dickinson, C. W. Kanolt, M. S. Van Dusen of the Bureau of Standards; P. Nicholls of the American Society of Heating and Ventilating Engineers; and R. D. Pike of San Francisco.

SPECTROSCOPY.—*Vanadium multiplets and Zeeman Effect.*[1] W. F. MEGGERS, Bureau of Standards.

In a note published last July[2] some regularities in the arc spectrum of vanadium were presented, showing that the multiplets arose from combinations of spectral terms whose maximum multiplicities were even and that the alternation of even and odd structures in arc spectra (alternation law of Kossel and Sommerfeld) was thus verified across the entire table of chemical elements. The vanadium multiplets represented combinations of spectral terms belonging either to quartet or to sextet systems or to intercombinations of these. The spectral lines belonging to each multiplet were selected on the basis

[1] Received February 20, 1924, Published by permission of the Director of the Bureau of Standards of the Department of Commerce.

[2] Meggers, This Journal **13**: 317. 1923.

of constant wave-number differences, temperature classification, and intensity rules accompanying transitions of azimuthal and inner quantum numbers. Some of the same multiplets were found independently by Laporte[3] of the University of Munich.

In an important paper on Term Structure and Zeeman Effect for Multiplets, Landé[4] gives a scheme of the Zeeman patterns for all spectral lines, thus providing another test of the discovered regularities and making it easy to find many more. In the present note, therefore, I am giving a few examples of several types of multiplets in the arc spectrum of vanadium together with the observed and calculated Zeeman effects for the spectral lines. Since the first note was published, the region of the spectrum from violet to red (4500 to 6500 A), in which wave length data of inferior quality existed, has been remeasured on the international scale. Most of the multiplets here discussed are selected from this interval. A table of new wave lengths and other multiplets will be published later in Scientific Papers of the Bureau of Standards.

In the following tables, each of which gives data for one multiplet, the scheme of term combinations is first given and then the observed and calculated Zeeman effects characteristic of the spectral lines are compared. In the arrangement of a multiplet, each spectral line is represented by its wave length in air, above which its arc intensity and temperature class[5] are given while the corresponding vacuum wave number is directly below.

The notation for spectral terms proposed by Landé (loc. cit.) is employed here, since the older notation is inadequate for general use in complex spectra. A spectral term is represented by $n_{k_j}^r$, where n is the total quantum number, k and j are the azimuthal and inner quantum numbers respectively and r is the maximum multiplicity of the system. Values of n are indeterminate until regular series of terms have been established, but the type of any term is fully determined by r, k and j. Quartet and sextet systems are represented respectively by $r = 4$ and $r = 6$; the values $k = 1, 2, 3, 4, 5$, etc., represent what were formerly known as S, P, D, F, G, etc., terms respectively. The j values distinguish the separate levels in poly-fold terms.

[3] Die Naturwissenschaften 11: 779. 1923.
[4] Zeit. f. Physik 15: 189. 1923.
[5] King, Astroph. Journ. 41: 86. 1915.

The Zeeman Effect for Vanadium was published by Babcock[6] for several hundred lines from 3665 A to 6625 A. His observed magnetic separations converted in terms of the separation of a normal triplet as a unit are given in the following tables for direct comparison with the separations calculated from Landé's rules. Parallel components are enclosed in parentheses, followed by the perpendicular components. In some cases, the calculated patterns are rather complex and only one or a few of the stronger components, are expressed in decimal form, the remaining weaker ones being represented by asterisks. Where two or more components are given, the one most intense is distinguished by bold face type. When very close together the magnetic components are often not fully resolved; they appear diffuse or widened. Babcock has indicated some of these cases with the letter w followed by a subscript 1, 2 or 3; w_3 representing the greatest widening observed. The fainter components are seldom observed separately but it is evident that they often influence the determination of the separations for the strong components. With these facts in mind, the agreement between observed and calculated Zeeman effect for vanadium lines must be regarded as fairly satisfactory.

TABLE 1.—VANADIUM MULTIPLET (TYPE PP′ QUARTET)

	n^4_{21}	*144.49*	n^4_{22}	*215.84*	n^4_{23}
n^4_{21}	3, IIIA 6565.88 15226.05		9, IIA 6504.16 15370.54		
92.42					
n^4_{22}	10, IIIA 6605.98 15133.63		5, IIIA 6543.51 15278.12		10, IIA 6452.35 15493.95
187.62					
n^4_{23}			7, IIIA 6624.86 15090.49		15, II 6531.44 15306.34

TABLE 1a—ZEEMAN EFFECT

λ	obs.	calc.
6565.88	±(0) 2.61	±(0) 2.67
6543.51	– ——	(0) 1.73
6531.44	(0) 1.57	(0) 1.60
6504.16	(0.52) **1.30**, 2.19	(0.47) **1.26**, 2.20
6605.98	(0.48) 1.34,——	" " "
6452.35	(0) 1.46	(0.07*) 1.40***
6624.86	(0) 1.36	" "

[6] Astroph. Journ. **34**: 209. 1911.

TABLE 2.—VANADIUM MULTIPLET (TYPE PD QUARTET)

	$n^4{}_{21}$	*72.93*	$n^4{}_{22}$	*26.23*	$n^4{}_{23}$
$n^4{}_{31}$	7, III 4626.48 21608.67		2, IIIA 4610.92 21681.57		
63.22					
$n^4{}_{32}$	8, III 4640.06 21545.42		8, III 4624.40 21618.38		2, — 4618.80 21644.60
102.31					
$n^4{}_{33}$			15, III 4646.40 21516.06		8, III 4640.74 21542.30
137.20					
$n^4{}_{34}$					25, III 4670.48 21405.10

TABLE 2a.—ZEEMAN EFFECT

λ	obs.	calc.
4610.92	±(0.90) ——	±(0.81) 0.81, **2.60**
4624.40	(0.85) $1.44w_2$	(0.26, **0.80**) 0.93, **1.46**, 2.00
4626.48	(1.32) 1.35	(1.33) 1.33
4640.06	(0.76) 0.35	(0.73) **0.47**, 1.94
4640.74	(0.45) 1.56	(** 0.57) ** 1.48 **
4646.40	(0) 1.00	(0.18*) 0.83 ***
4670.48	(0) 1.18	(0.09**) 1.00 *****

TABLE 3.—VANADIUM MULTIPLET (TYPE PD QUARTET)

	$n^4{}_{21}$	*144.50*	$n^4{}_{22}$	*215.86*	$n^4{}_{23}$
$n^4{}_{31}$	25,II 6111.62 16357.75		5, IIA 6058.11 16502.23		
63.26					
$n^4{}_{32}$	15, II 6135.36 16294.47		25, I 6081.42 16439.00		4, IIA 6002.60 16654.84
102.30					
$n^4{}_{33}$			40, I 6119.50 16336.68		25, I 6039.69 16552.57
137.24					
$n^4{}_{34}$					50, I 6090.18 16415.33

TABLE 3a.—ZEEMAN EFFECT

λ	obs.	calc.
6002.60	±(0) 2.01	±(0.20*) ***.2.20
6039.69	(0.49) 1.44	(** 0.57) ** 1.48 **
6058.11	(0.85) **0.85**, 2.54	(0.81) 0.81, **2.60**
6081.42	(—, 0.79) 0.89, **1.44**, 1.98	(0.26, **0.80**) 0.93, **1.46**, 2.00
6090.18	(0) 1.22	(0.09**) 1.00 *****
6111.62	(1.28) 1.26	(1.33) 1.33
6119.50	(0.19, 0 55) —, —, —, 1.01	(0.18, 0.54) **0.83**, 1.19, 1.55, 1.91
6135.36	(0.70) **0.50**, 1.86	(0.73) **0.47**, 1.94

TABLE 4.—VANADIUM MULTIPLET (TYPE DD′ QUARTET)

	n^4_{31}	*66.80*	n^4_{32}	*103.22*	n^4_{33}	*127.67*	n^4_{34}
n^4_{31}	8, II 5626.01 17769.65		8, II 5604.94 17836.46				
63.26							
n^4_{32}	10, II 5646.11 17706.40		10, II 5624.90 17773.19		12, I 5592.41 17876.44		
102.30							
n^4_{33}			12, II 5657.45 17670.92		20, I 5624.60 17774.11		10, I 5584.49 17901.78
137.23							
n^4_{34}					12, II 5668.37 17636.88		30, I 5627.63 17764.55

TABLE 4a.—ZEEMAN EFFECT

λ	obs.	calc.
5626.01	unaffected	unaffected
5624.90	±(0) 1.16	±(0) 1.20
5624.60	(0) 1.37	(0) 1.38
5627.63	(0) 1.44	(0) 1.43
5604.94	(0.59) **0.58**, 1.83	(0.60) 0.60, **1.80**
5646.11	(0.60) 0.58, **1.79**	" " "
5592.41	(0) 1.52	(0.09*) *** 1.63
5657.45	(0) 1.50	" " "
5584.49	(0) 1.52	(0.03**) ***** 1.57
5668.37	(0) 1.51	" " "

TABLE 5.—VANADIUM MULTIPLET (TYPE DF QUARTET)

	n^4_{42}	*73.74*	n^4_{43}	*117.84*	n^4_{44}	*222.88*	n^4_{45}
n^4_{31}	30, I 5706.97 17517.58						
63.28							
n^4_{32}	20, II 5727.66 17454.30		40, I 5703.56 17528.06				
102.26							
n^4_{33}	2, IIIA 5761.41 17352.06		25, II 5737.04 17425.77		60, I 5698.51 17543.59		
137.26							
n^4_{34}			2, IIIA 5782.60 17288.48		18, II 5743.44 17406.35		30, I 5670.83 17629.23

TABLE 5a.—ZEEMAN EFFECT

λ	obs.	calc.
5670.83	±(0) 0.66w₃	±(0.05***) 1.00, *******
5698.51	(0) 0.97w₂	(0.07**) 0.90, *****
5703.56	(0) 0.93	(0.09*) 0.77, ***
5706.97	(0) 0.56w₂	(0.20) 0.20, **0.60**
5727.66	(1.10) 0.00, 0.84, 1.56	(0.40, **1.20**) 0.00, **0.80**, 1.60
5737.04	(0.77) 1.23w₃	(** 0.86) ** 1.20 **
5743.44	(0.79) 1.32w₂	(*** 0.67) *** 1.34 ***

TABLE 6.—VANADIUM MULTIPLET (TYPE FF′ QUARTET)

	n^4_{42}	*122.48*	n^4_{43}	*142.54*	n^4_{44}	*166.78*	n^4_{45}
n^4_{42}	30, I 4330.03 23088.04		12, I 4307.19 23210.50				
137.38							
n^4_{43}	10, I 4355.96 22950.64		30, I 4332.83 23073.13		15, I 4306.22 23215.70		
186.04							
n^4_{44}			10, I 4368.05 22887.12		40, I 4341.02 23029.63		20, I 4309.80 23196.42
229.60							
n^4_{45}					125, II 4384.73 22800.04		50, I 4352.89 22966.81

TABLE 6a.—ZEEMAN EFFECT

λ	obs.	calc.
4330.03	±(0) 0.40	±(0) 0.40
4332.83	(0) 1.00	(0) 1.02
4341.02	(0) 1.21	(0) 1.24
4352.89	(0) 1.31	(0) 1.33
4307.19	(0) 1.49w_2	(0.31*) *** 1.98
4355.96	(w_3) 1.71	" "
4306.22	(0) 1.49	(0.10**) ***** 1.76
4368.05	(w_1) 1.56	" "
4309.80	(0) 1.47	(0.04***) ******* 1.67
a4384.73	(0) 1.18	" "

(a) This line is an unresolved double and the Zeeman data probably refer to the stronger component which belongs to a different multiplet (Type DF Sextet, (0.08***) 0.90*******).

TABLE 7.—VANADIUM MULTIPLET (TYPE FG QUARTET)

	n^4_{53}	*122.05*	n^4_{54}	*157.64*	n^4_{55}	*192.83*	n^4_{56}
n^4_{42}	40, I 4577.17 21841.44						
137.38							
n^4_{43}	15, I 4606.15 21704.06		40, I 4580.39 21826.14				
186.06							
n^4_{44}	1, IIIA 4645.97 21518.03		25, I 4619.77 21640.05		50, I 4586.36 21797.68		
229.54							
n^4_{45}			2, — 4669.30 21410.50		15, I 4635.18 21568.14		60, I 4594.10 21760.97

TABLE 7a.—ZEEMAN EFFECT

λ	obs.	calc.
4577.17	±(0) 0.72	±(0.09*) **** 0.83
4580.39	(0) 0.91	(0.02**) 0.87 *****
4586.36	(0) 1.04	(0.03***) 0.98 *******
4594.10	(0) 1.10	(0.03****) 1.00 *********
4606.15	(1.06) —	(**1.14) ** 0.80 **
4619.77	(0) 0.98	(***0.89) *** 1.11 ***
4635.18	(0.61) 1.26D	(**** 0.73) **** 1.25 ****

TABLE 8.—VANADIUM MULTIPLET (TYPE PD SEXTET)

	n^6_{22}	*79.74*	n^6_{23}	*110.73*	n^6_{24}
n^6_{31}	15, I 4436.14 22535.82				
40.95					
n^6_{32}	20, I 4444.22 22494.87		15, I 4428.52 22574.59		
66.94					
n^6_{33}	15, I 4457.48 22427.91		25, I 4441.69 22507.67		12, I 4419.94 22618.38
91.23					
n^6_{34}			30, I 4459.77 22416.43		20, I 4437.84 22527.18
113.43					
n^6_{35}					50, I 4460.30 22413.75

TABLE 8a.—ZEEMAN EFFECT

λ	obs.	calc.
4419.94	±(0) 1.73	±(0.03**) ***** 1.86
4428.52	(0) 1.82	(0.01*) *** 1.92
4436.14	(0.51) **1.83**, 2.76	(0.47) **1.94**, 2.88
4437.84	(w_3) 1.60	(***0.44) *** 1.66 ***
4441.69	(0.55) 1.72	(**0.57) ** 1.77 **
4444.22	(0.76) 2.06	(* 0.80) * 2.13 *
4457.48	(w_3) 0.52, 1.17	(0.37 *) **0.54**, 1.28 **
4459.77	(w_2) 0.99	(0.15 **) 0.84 *****
4460.30	(0) 1.22	(0.08 ***) 1.00 *******

TABLE 9.—VANADIUM MULTIPLET (TYPE DD′ SEXTET)

	n^6_{31}	*40.40*	n^6_{32}	*68.22*	n^6_{33}	*98.92*	n^6_{34}	*133.50*	n^6_{35}
n^6_{31}	a 4116.61 24284.99		50, I 4109.78 24325.36						
40.90									
n^6_{32}	60, I 4123.56 24244.06		4, I A 4116.70 24284.48		60, I 4105.17 24352.70				
66.93									
n^6_{33}			60, I 4128.08 24217.55		50, I 4116.48 24285.77		60, I 4099.80 24384.60		
91.24									
n^6_{34}					60, I 4132.02 24194.45		60, I 4115.18 24293.45		50, I 4092.69 24426.91
113.48									
n^6_{35}							60, I 4134.50 24179.93		100, I 4111.79 24313.47

TABLE 9a.—ZEEMAN EFFECT

λ	obs.	calc.
a4116.61	— — — —	±(0) 3.33
b4116.48	±(0) 1.60, 3.29	(0) 1.66
4115.18	(0) 1.53	(0) 1.58
4111.79	(0) 1.46	(0) 1.56
4109.78	(0.71) 1.07, 2.48	(0.73) 1.14, 2 60
4123.56	(0.76) 1.08, 2.52	" " "
4105.17	(0) 1.47	(0.10 *) 1.34 ***
4128.08	(0) 1.47	" "
4099.80	(0) 1.43	(0.04 **) 1.41 *****
4132.02	(0) 1.45	" "
4092.69	(0) 1.40	(0.02 ***) 1.44 *******
4134.50	(0) 1.45	" "

a. Although the line 4116.61 A is not recorded in any published wave length tables, Professor H. N. Russell informs me it is clearly visible in the Mt. Wilson sun-spot spectrum in which the lines of this multiplet are perceptibly strengthened.

b. The component 3.29 probably belongs to 4116.61 A.

TABLE 10.—VANADIUM MULTIPLET (TYPE DD′ SEXTET)

	n^6_{31}	*40.40*	n^6_{32}	*71.92*	n^6_{33}	*104.22*	n^6_{34}	*135.80*	n^6_{35}
n^6_{31}	8, IIA 6258.60 15973.62		15, I 6242.80 16014.04						
40.94									
n^6_{32}	15, I 6274.67 15932.70		—, — 6258.80 15973.09		30, I 6230.74 16045.04				
67.08									
n^6_{33}			20, I 6285.18 15906.04		8, IIA 6256.91 15977.92		30, I 6216.37 16082.12		
91.26									
n^6_{34}					20, I 6292.86 15886.64		30, I 6251.83 15990.89		30, I 6199.20 16126.65
113.45									
n^6_{35}							15, I 6296.52 15877.41		30, I 6243.11 16013.24

TABLE 10a.—ZEEMAN EFFECT

λ	obs.	calc.
6258.60	±(0) 3.22	±(0) 3.33
a6258.80	— —	(0) 1.86
6256.91	(0) 1.61	(0) 1.66
6251.83	(0) 1.54	(0) 1.58
6243.11	(0) 1.56	(0) 1.56
6242.80	(0.76) 1.80	(0.73) 1.14, 2.60
6274.67	(0.62) 1.25, 2.45	" " "
6230.74	(0) 1.40	(0.10 *) 1.34 ***
6285.18	(0) 1.56	" "
6216.37	(0) 1.46	(0.04 **) 1.41 *****
6292.86	(0) 1.50	" "
6199.20	(0) 1.46	(0.02 ***) 1.44 *******
6296.52	(0) 1.51	" "

a. This line is either absent or abnormally weak.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE GEOLOGICAL SOCIETY

373D MEETING

The 373d meeting was held in the Cosmos Club, October 25, 1922, with President Alden in the chair and 52 persons present.

Program: E. S. LARSEN: *Origin of some corundum-bearing rocks.*

EDWARD SAMPSON: *Ferruginous cherts of Notre Dame Bay, Newfoundland.* This paper was discussed by Messrs. H. S. WASHINGTON, T. W. VAUGHAN, and C. A. MATLEY, Government Geologist of Jamaica, with replies by Mr. Sampson.

E. G. ZIES: *Fumarole minerals of the Katmai region.* This paper was discussed by Messrs. HESS, HEWETT, WELLS, and FOSHAG, with replies by Mr. Zies.

374TH MEETING

The 374th meeting was held in the Cosmos Club, November 8, 1922, with President Alden in the chair and 56 persons present.

Informal communication: David White discussed the Pleistocene cypress swamp in the excavation for the Walker Hotel, Connecticut avenue and L street.

Program: C. A. MATLEY, Government Geologist of Jamaica: *Notes on the Lameta formation of India and its dinosaurian remains.* Dr. Matley's paper was discussed by Messrs. WHITE, VAUGHAN, and REESIDE, with replies by Dr. Matley.

A. C. SPENCER: *The geology of dam sites.* This paper was discussed by Messrs. VAUGHAN, LEE and MISER.

G. F. LOUGHLIN: *The ore deposits of Leadville.*

375TH MEETING

The 375th meeting of the Geological Society was held in the Cosmos Club, November 22, 1922, President Alden presiding and 48 persons present.

Program: G. E. P. SMITH, Irrigation Engineer, University of Arizona: *The effect of transpiration of trees on the ground-water supply.* Prof. Smith's paper was discussed by Messrs. BRYAN and THOMPSON.

AUGUSTUS LOCKE: *Outcrops and ore deposits.* Discussion by A. C. SPENCER AND D. F. HEWETT; questions by H. G. FERGUSON and SIDNEY PAIGE; and replies by Mr. Locke.

376TH MEETING

The 376th meeting was held in the Cosmos Club, December 13, 1922, with Vice-President Stephenson in the chair and 73 persons present. The retiring president, W. C. ALDEN, delivered his Presidential address: *The physiographic development of the northern Great Plains.*

30TH ANNUAL MEETING

The 30th annual meeting was held in the Cosmos Club, December 13, 1922, with President Alden in the chair and 55 members present. The following officers were elected for the ensuing year: *President,* G. F. LOUGHLIN;

Vice-Presidents, L. W. STEPHENSON and W. T. LEE; *Treasurer*, H. D. MISER; *Secretaries*, KIRK BRYAN and C. WYTHE COOKE; *Members-at-large* of the Council, NORMAN L. BOWEN, JOHN D. NORTHROP, OSCAR E. MEINZER, PAUL V. ROUNDY, GEORGE STEIGER; Nominee for Vice-President, Washington Academy of Sciences, WM. C. ALDEN.

377TH MEETING

The 377th meeting was held in the Cosmos Club, January 10, 1923, with President Loughlin presiding and 57 persons present.

Informal communication: Lawrence LaForge discussed the excavation for the Walker Hotel.

Program: A. J. COLLIER: *Some features of the geology of the Little Rocky Mountains.* Discussed by Messrs. MEINZER, HEALD, REEVES, WHITE, VAUGHAN, and SPENCER.

M. R. CAMPBELL: *The Pulaski overthrust fault of southwestern Virginia.* Discussed by Messrs. STOSE, SPENCER, ULRICH, and VAUGHAN.

N. H. DARTON: *Some Arizona problems.* Discussed by Messrs. MISER, LEE, REESIDE, WHITE, SPENCER, and HEALD.

JOINT MEETING

A joint meeting with the Washington Academy of Sciences was held in the Cosmos Club, January 24, 1923, with President T. Wayland Vaughan of the Washington Academy of Sciences in the chair and 87 persons present.

Program: Prof. EMMANUEL DE MARGERIE, Director of the Geological Survey of Alsace-Lorraine: *The structure of the Alps.*

378TH MEETING

The 378th meeting was held in the Cosmos Club, February 14, 1923, with President Loughlin in the chair and 66 persons present.

Informal communications: T. Wayland Vaughan announced the discovery of *Orthophragmina* in the Ocala limestone of Peninsular Florida. D. F. Hewett reported a wider distribution of Jarosite than had heretofore been supposed. Discussed by President Loughlin.

Program: FRANK REEVES: *Geological structure of the Bearpaw Mountains, Montana.*

W. T. THOM, JR.: *Origin of the structural features of Montana and Wyoming.*

These papers were discussed by Messrs. LEE, HEWETT, VAN ORSTRADD, MANSFIELD, WHITE AND LOUGHLIN.

379TH MEETING

The 379th meeting was held in the Cosmos Club, February 28, 1923, with President Loughlin in the chair and 48 persons present.

Program: CHARLES BUTTS: *Geological sections and crustal shortening in central Pennsylvania.* Discussed by Messrs. MANSFIELD, LEE, WHITE, BOWIE, and LA FORGE, with replies by Mr. Butts.

GEORGE W. STOSE and ANNA I. JONAS: *Ordovician overlap in the Piedmont of Pennsylvania and Maryland.* Discussion by Miss BASCOM, and Messrs. BASSLER, KEITH, GOLDMAN, and BUTTS, with replies by the speakers.

380TH MEETING

The 380th meeting was held in the Auditorium of the Department of the Interior, March 14, 1923, in joint session with the Washington Academy of Sciences, the Biological Society of Washington, and the Botanical Society of Washington, President Loughlin presiding and 350 persons present. The program consisted of a symposium on: *The fossil swamp deposit at the Walker Hotel site, Connecticut Ave. and De Sales Street, Washington, D. C.* The papers presented at this meeting have been printed in this JOURNAL (Vol. 14, No. 1).

381ST MEETING

The 381st meeting was held at the Cosmos Club, March 28, 1923, President Loughlin presiding and 49 persons present.

Informal communication: Frank L. Hess: *Quartz glass.*

The regular program was a discussion of the problem of the Tertiary-Quaternary boundary. JOHN C. MERRIAM: *Pliocene and Pleistocene deposits of California.* LAURENCE LAFORGE: *Résumé of the Pliocene-Pleistocene question.*

SPECIAL MEETING

A special meeting of the Geological Society was held jointly with the U. S. Army Air Service in the Auditorium of the Interior Building, April 10, 1923, with General William Mitchell presiding and 200 persons present.

Program: Geology as seen from the air.

Wing Commander M. G. CHRISTIE, of the British Embassy, described his use of the geology of England in aviation. WILLIS T. LEE gave illustrated notes on American geology. Motion pictures of the Grand Canyon and of Vesuvius in eruption were shown.

382D MEETING

The 382d meeting of the Society was held at the Cosmos Club, April 11, 1923, with President Loughlin in the chair and 47 persons present.

Informal communication: CHARLES BUTTS: *Fossil algae in the Ocoee formation.*

Program: KIRK BRYAN: *Pedestal rocks near Lees Ferry, Arizona.*

J. D. SEARS: *Relation of the Browns Park formation and the Bishop conglomerate and their rôle in the origin of Green River.* Discussed by Messrs. LEE, REESIDE, ALDEN, CAPPS, and SAMPSON.

FRANK L. HESS: *Uses of the rarer metals.*

JOINT MEETING

A joint meeting Society with the Washington Academy of Sciences and the Philosophical Society was held in the Auditorium of the Interior Building April 18, 1923, President Vaughan of the ACADEMY presiding and 175 persons present.

Program: The Taylor and Wegener hypotheses on the lateral migration of land masses. FRANK B. TAYLOR: *The lateral migration of land masses.* R. A. DALY: *A critical review of the hypotheses.* W. D. LAMBERT: *The mechanics of the hypotheses.*

383D MEETING

The 383d meeting was held at the Cosmos Club, May 9, 1923, with President Loughlin in the chair and 46 persons present.

Informal communications: Laurence LaForge called attention to an article by R. L. Sherlock in the April, 1923, issue of the Geographical Journal on the influence of man as an agent in geographical change.

Program: WILLIAM BOWIE: *The theory of isostasy and its significance in geology.*

384TH MEETING

The 384th meeting was held at the Cosmos Club, November 14, 1923.

Informal communications: W. C. MENDENHALL exhibited a series of colored panoramas of the Alps, sent by Prof. E. de Margerie to Prof. W. H. Holmes.

Program: M. R. CAMPBELL: *Value of airplane photographs in geologic mapping.* Considerable speculation has been indulged in regarding the value of airplane photographs in geologic mapping. During the past summer the writer had the good fortune to have such photographs of a considerable portion of a coal field he was mapping on the edge of the Great Valley where it is crossed by New River in southwestern Virginia.

The photographs were taken with a Bagley three-lens camera at an altitude of about 12,000 feet, giving a scale of about 3 inches to the mile. Although the scale is small, almost every object in the landscape could be identified, even down to individual trees, and the writer was surprised at the great amount of detail showing on densely brush-covered ridges and in forested regions.

The photographs were given serial numbers in the order in which the flight was made. Each morning the writer selected such prints as covered the territory to be examined during the day, and these were clamped to a large square notebook by a steel desk clamp. Geologic boundaries were sketched directly on the photographs with a soft pencil, but descriptive notes had to be written in the notebook with tie letters or numbers to show their location on the map. Strike lines could not be plotted directly on the photographs, until the photograph was oriented by the determination of the bearing of some straight line, such as a straight stretch of road or some land line.

Great saving of the time and energy of the geologist was effected because, with the photographs in hand, it was rarely necessary to resort to pacing in order to determine location, for the forests and even individual trees, fence lines, and farm crops, together with roads, railroads, streams if large, and most objects of the landscape, were clearly recognizable. Another great saving in time was effected by the aid the photographs gave in finding old roads in wooded areas, in showing at once how one might cross certain territory where there are no public roads, and in enabling one to determine his location in dense brush and even in forested areas.

The writer estimates that in doing geologic mapping by the aid of airplane photographs, in such an area as that mentioned above, fully 50 per cent of the time of the geologist is saved and much greater accuracy of location is obtained than is possible by the use of the best contour map, unless a planetable survey is made when the geologic work was being done.

The cost of aerial photographs has not yet been determined, but it appears not to be prohibitive and, considering the saving that may be effected, it may prove to be cheaper than ordinary mapping. (*Author's abstract.*)

GEORGE S. RICE: *Origin of pockets of high pressure gas in coal mines.* Local concentrations of high pressure gas in crushed coal where the measures have been contorted or compressed by geologic movements constitute a serious menace to life in coal mining in Belgium and British Columbia, where the gas is principally methane; and in small coal basins of central France, where the gas is carbon dioxide. The most disastrous outburst of coal dust and gas occurred in 1879 at the Agrappe Mine, Mons, Belgium, in which the gas reversed the ventilation, smothered 121 men, became ignited at the top of the shafts, and burned four hours. Outbursts of the kind are not known to have occurred in mining operations in the United States, but may occur in future deep mining in the western mountains and in Alaska.

Unsatisfactory hypotheses that have been advanced to explain these outbursts are: (1) accumulation of gas in pores and cavities; (2) Morin's theory of decomposition of coal after relief of pressure; (3) Ruelle's theory first of polymerization of hydrocarbons then of reversion to a gaseous state after relief of pressure. A better explanation is that carbon dioxide gas migrates to the crushed area, becomes trapped, and pressure possibly increased by subsequent earth movements. Hydrocarbon gas may be distilled locally and increase the pressure. Experiments have shown that pulverized coal will adsorb 3 or 4 times its volume of gas under atmospheric pressure; under high pressure a vastly greater volume might be adsorbed. Gas may be held in practically liquid state by the surface tension of minute particles, some almost molecular, which have in the aggregate a vast amount of surface. (*Author's abstract.*)

385TH MEETING

The 385th meeting was held in the Auditorium of the Department of the Interior, November 28, 1923.

Program: D. F. HEWETT: *Dolomitization near Goodsprings, Nevada.* Upper Paleozoic limestones of southern Nevada are widely altered to dolomite. The alteration is shown (1) by the change in color from dark and light gray to cream and white; (2) by a change in texture from very fine grained to medium or coarse grained; and (3) by a change in chemical composition from material containing 94 to 99.5 per cent calcium carbonate to that containing from 90 to 98 per cent dolomite. The process of alteration also involved the elimination of carbonaceous matter, the addition of small amounts of iron and silica, and generally the obliteration of fossil remains. It was accomplished without appreciable change in volume of the rocks.

The altered rock is sharply separable from the original limestone and the surface of contact is commonly either bedding or joint planes, but here and there in homogeneous material is a smoothly irregular surface. Where the limestones are thin-bedded (Devonian and Pennsylvanian) some beds are extensively altered and others nearby are not affected. They are not altered over such large areas as the massive limestones (Lower and Upper Mississippian). One massive bed, about 300 feet thick, is almost completely altered over an area 10 by 20 miles. The overlying thinner beds are altered only over areas that range from a few hundred to 10,000 feet square. Locally,

groups of beds 1500 to 2000 feet thick are completely altered over such areas.

The process of dolomitization appears to be related to the intrusion in early Tertiary time of a group of small sills and dikes of orthoclase porphyry and to the deformation which the rocks underwent during and following their intrusion. The intrusives appeared early in a period of thrust faulting, which was followed by a group of early normal faults. Locally, masses of rock adjacent to these faults are altered to dolomite. No dolomitization is associated with a later system of normal faults. In late Tertiary times small necks of dense latites locally dolomitized the adjacent limestones, or if they intruded dolomite, accomplished a slight hydration and locally formed veins of brucite.

The process of dolomitization is related to and probably culminated in the deposition of bodies of lead and zinc minerals now exploited in the region. It is a type of hydrothermal alteration. (*Author's abstract.*)

W. T. THOM, JR., and C. E. DOBBIN: *Correlation of the Lebo member of the Fort Union with Cannonball member of the Lance.* Recent field work indicates that in the Plains basin of eastern Montana and western Dakota sedimentation continued without important interruption from marine Cretaceous into Wasatch Eocene. The Lance and Fort Union formations are separable into several lithologic units of large areal extent, and of alternating somber and yellow aspect. In Montana, Fox Hills sandstone is overlain in ascending order by the Hell Creek and Tullock members of the Lance; by the Lebo and Tongue River members of the Fort Union; by the Sentinel Butte shale (Fort Union?); and by the Wasatch Ulm coal group. In Dakota, the Hell Creek member (Lance) is overlain by the interfingering Ludlow, and Cannonball marine members of the Lance; by the Tongue River member of the Fort Union; and by the Sentinel Butte shale; the upper part of the Ludlow and Cannonball members being equivalent to the Lebo shale member of the Fort Union of areas farther west.

The faunal, floral, and lithologic evidence all indicates the local continuity of sedimentation from Fox Hills into Wasatch. The Cretaceous-Eocene contact is provisionally placed at the top of the Tongue River member of the Fort Union, although the base of the member, or the top of the Sentinel Butte shale, may eventually be found to be more convenient planes of separation after further work in related areas.

C. E. DOBBIN and J. B. REESIDE, JR.: *The Lance-Fox hills contact in eastern Montana and the Dakotas.* In this paper were presented conclusions regarding the relations between the Fox Hills and Lance formations, conclusions which have a direct bearing upon the solution for this particular region at least, of the "Laramie Problem." It was shown that the reported unconformities between the Fox Hills and Lance are misinterpretations of geologic relations. It was also shown that the Fox Hills of the Dakotas, containing a Marine Upper Cretaceous invertebrate fauna, can be traced directly into the Fox Hills of Montana which locally contains a Fort Union or early Eocene flora. Evidence was presented to show that the Fox Hills and Lance represent continuous deposition, the Fox Hills of Montana being

deposited in marine, brackish, and fresh water contemporaneous with the deposition in a receding sea, of the Marine Fox Hills of the Dakotas while the Lance represents the inauguration of delta and flood plains deposits succeeding the retreat of the Interior Sea to the east. (*Authors' abstract.*)

This paper and the preceding were discussed by Messrs. STANTON, STOSE, THOM, MANSFIELD, and LEE.

386TH MEETING

The 386th meeting was held at the Cosmos Club, December 12, 1923. The presidential address of the retiring president, Dr. GERALD F. LOUGHLIN, *The development and outlook of economic geology*, was delivered. The address will be printed in the Journal of the Washington Academy of Sciences.

The 31st annual meeting was held at the Cosmos Club after the adjournment of the 386th meeting. The following officers were elected for the year 1924: *President:* FRED. E. WRIGHT; *Vice-Presidents:* L. W. STEPHENSON, D. F. HEWETT; *Treasurer:* JOHN B. REESIDE, JR.; *Secretaries:* C. WYTHE COOKE, EDWARD SAMPSON; *Members-at-Large of the Council:* F. C. CALKINS, S. H. CATHCART, W. F. FOSHAG, F. L. HESS, H. E. MERWIN.

C. WYTHE COOKE, *Secretary*.

SCIENTIFIC NOTES AND NEWS

The following meetings of national scientific and technical organizations are scheduled to be held in Washington this spring:

April 18. Association of Makers and Users of Scientific Apparatus.
April 21–26. American Chemical Society.
April 25–26. American Physical Society.
April 28–30. National Academy of Sciences.
May 1–3. American Geophysical Union.

MATTHEW W. STIRLING has resigned as assistant curator, Division of Ethnology, National Museum, to assume new duties in Florida.

HENRY MALLEIS, of the Biological Survey, has returned to the Petén District of Guatemala, where he will endeavor to obtain live specimens of the ocellated turkey for introduction on one of the islands off the coast of Georgia.

ROBERT P. NEVILLE, associate chemist in the Bureau of Standards, died on February 3, 1924, after an illness of several months. Mr. Neville was born September 23, 1894, in Arlington, Kentucky. He was graduated from Baylor University, Waco, Texas, with the degrees of A.B. and A.M. Coming directly from his university work to the Bureau of Standards in 1918, he became a member of the Division of Metallurgy of that Bureau. Mr. Neville's chief scientific work was the preparation and study of the properties of pure iron and several series of its alloys. Recently his attention had been turned in part to investigations of the technic of melting and mechanical working of very pure platinum metals and their alloys.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 APRIL 19, 1924 No. 8

PHYSICAL CHEMISTRY.—*The densities and specific volumes of sodium chloride solutions at 25°.*[1] RALPH E. HALL, Geophysical Laboratory, Carnegie Institution of Washington.

INTRODUCTION

This work was undertaken because of a need for accurate specific volume data on concentrated sodium chloride solutions at 25°. The data available, reference to which will be made later, either did not meet the necessary requirements of concentration, or else required an interpolation over a wide range of temperature or concentration.

APPARATUS AND MATERIALS

Pycnometers.—The type of pycnometer used is shown in Fig. 1, and is similar to that described by Bousfield.[2] While Bousfield's procedure was such that he hung the pycnometer in the thermostat by a convenient support, the pycnometers used in this work were placed in a wire basket which supported them during the time they were in the thermostat, so that they were subject to practically no strain.

Thermostat and temperature control.—The thermostat was a well lagged, porcelain-lined vessel of about 15 gallons (57 liters) capacity. The stirring was thorough. Heat was furnished by a resistance element so connected with lamps in parallel that the make and break of the relay produced only a slight variation in the current passing through it. The relay was of a special type with carbon contacts, and the periods between make and break were of 30 to 40 seconds duration. A mercury regulator was used. The pycnometer was

[1] Received March 3, 1924.

[2] Journ. Chem. Soc. London, **93**: 679. 1908.

always placed in the same position in the thermostat, and close beside it was one leg of a 10-junction thermel, the reference leg being immersed in ice in a thermos bottle. The thermel was calibrated by comparison with Dr. L. H. Adams' 50 junction element which had been calibrated by comparison with the 24-junction standard element of this laboratory, made by Dr. Walter P. White and calibrated by the Bureau of Standards. The e.m.f. of the thermel was read by means of a Wolff potentiometer, the standard cell of which was checked by the Bureau of Standards shortly after the work was done. A millimeter division on the scale represented 0.0025°; and the temper-

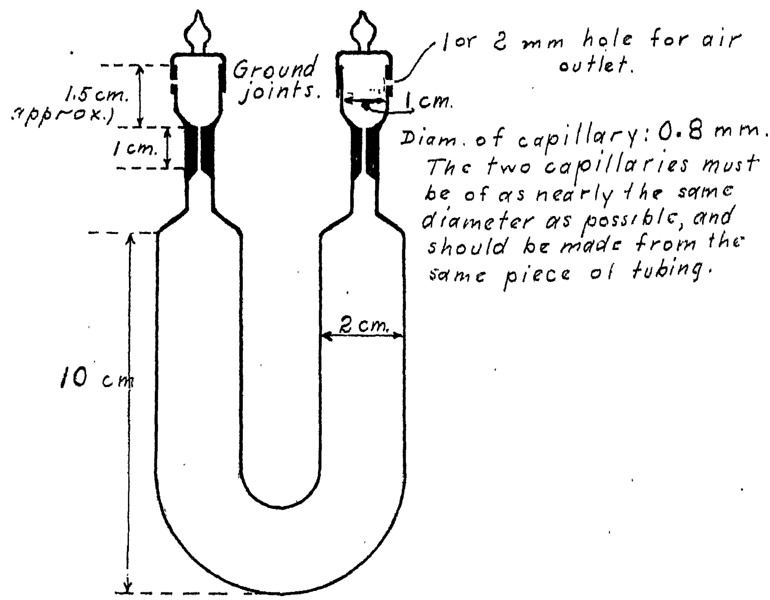


Fig. 1.—Pycnometer used for the determination of the densities of sodium chloride solutions at 25°.

ature of the thermostat was maintained constant within this limit at the point at which the thermel was inserted. It was our intention to work at 25°; but when the certificate on the standard cell was available, we found that our temperature was 25.01°. All final results have been corrected to 25°.

The balance.—This was a high grade Ainsworth balance. The ratio of the arms (L/R) was 1.000 000 3, so that in double weighing, which was followed throughout the work, only a slight difference in the weights resulted by exchanging load and weights. The results of all

weighings were reduced to vacuum, the barometer reading and the temperature and humidity in the balance case being recorded at the time of each weighing.

The weights.—The weights used were calibrated just prior to this work by comparison with the standard weights of this laboratory, certified by the Bureau of Standards.

Water.—Ordinary distilled water was distilled from alkaline permanganate, and collected in an atmosphere of steam. It was kept in tightly stoppered bottles. This water had a conductivity at 25° of about 2×10^{-6}. Before use it was heated to boiling again, and then quickly cooled before its introduction into the pycnometer. At no time did any bubbles become apparent in the pycnometer after the necessary time in the thermostat for temperature equilibrium to be reached.

Salt.—Squibb's "Reagent" sodium chloride was used. It was once recrystallized by solution in water and evaporation to half recovery. These crystals were sucked comparatively dry, washed once with distilled water, air dried until all tendency to adhere together or to the glass had disappeared, and finally subjected in platinum dishes to a temperature of 500 to 600° for 5 to 8 hours.

Solutions.—All solutions were made up entirely independently. The salt was weighed in a platinum dish, transferred to a funnel, and washed into a 100 cc. "R" volumetric flask, whose weight was known, with the hot water used in making the solution. The body of the flask was nearly filled with hot water, and given a swirling motion until the salt was all dissolved, when enough water was added to bring the solution about a centimeter above the mark. The flask, stoppered, was now placed in a large beaker of distilled water at room temperature for ten or fifteen minutes, then was removed, wiped off carefully with a linen cloth, and placed in the balance case. At the end of half an hour, it was double weighed, no tare being used. The contents of the flask were now thoroughly mixed, so that the solution was homogeneous, and were transferred to the dry pycnometer. By this procedure, the amount of air taken up by the solution was kept small enough so that no bubbles ever appeared on the surface of the pycnometer.

EXPERIMENTAL PROCEDURE

When the pycnometer was first introduced into the thermostat, the little cups above the capillaries were partially filled with solution.

After about five minutes, this excess solution was removed by absorption in filter paper. After ten minutes more, a first adjustment to the marks on the capillaries was made. The pycnometer was left in the thermostat about fifteen minutes more, and further adjustment made if necessary. Before its removal from the bath, the cups were wiped out with dampened filter paper, to remove any traces of salt which might have collected. Both the tare and the pycnometer containing the solution were dipped into distilled water and wiped with a damp linen cloth, whereupon they were hung in the balance case. Equilibrium as to weight was reached in a half hour's time.

TABLE 1.—Constancy of the Relation between the Solution-Pycnometer and the Tare-Pycnometer during the Experimental Work

After	(Tare-pycnometer)-(solution-pycnometer)
8 water determinations	0.00130 grams
1 salt solution determination	0.00142
2 salt solution determination	0.00152
2 salt solution determination	0.00142
4 salt solution determination	0.00139
5 salt solution determination	0.00130
Average..............................	0.0014

In making the corrections to vacuum, the density of the solution was considered to be its density at 25°. No appreciable error was introduced by this assumption, as the temperature of the balance case varied only from 21 to 25°.

WEIGHT CONSTANCY OF THE SOLUTION PYCNOMETER

The constancy of the relation between the pycnometer used as a tare and the one used to hold the solutions is illustrated by the figures of table 1, which were obtained, as indicated by column 1, at the various intervals in the series of experiments. Before each comparison, and also before each determination of weight of solution, the solution-pycnometer was washed out with bichromate cleaning fluid, then with distilled water, and dried by sucking air through it. No precautions were taken to filter the air, as the room was quite free from dust.

The consistency of the results presented in column 2 leads to the conclusion that errors from any dissolving of the surfaces are negligible. The first three water determinations of the eight mentioned in column 1 were discarded, as they were made using the upper marks

on the capillaries, and it was found that better adjustment could be obtained by using the lower marks. In all calculations, the difference between tare- and solution-pycnometer was taken as 0.0014 gram.

VOLUME OF THE SOLUTION-PYCNOMETER

The determinations with pure water for obtaining the volume of the solution-pycnometer resulted as follows:

NUMBER OF DETERMINATION	WEIGHT OF WATER (GRAMS)
1	54.8779
2	54.8771
3	54.8772
4	54.8791
5	54.8774
6	54.8778
Average (exclusive of No. 4)...........	54.8775

Nos. 1–5 were made before using the pycnometer with the solutions; No. 6 was made at the close of the work. No. 4 has been omitted from the average, as the pycnometer was filled in the evening, and

TABLE 2.—SUMMARY OF DETERMINATIONS ON NaCl SOLUTIONS

WEIGHT OF SALT	WEIGHT OF SOLUTION	CONCENTRATION, PER CENT	WEIGHT OF SOLUTION IN PYCNOMETER	DENSITY 25.01°/4°	DENSITY 25°/4°
1.0017	100.4946	0.99673	55.2647	1.00410_3	1.00410_6
2.0586	101.8605	2.0210	55.6620	1.01132_2	1.01132_5
5.0123	103.8832	4.8249	56.7582	1.03123_8	1.03124_1
5.0027	103.8421	4.8176	56.7558	1.03119_5	1.03119_8
10.8000	108.0488	9.9955	58.8257	1.06880_3	1.06880_7
10.7999	108.1625	9.9849	58.8216	1.06872_8	1.06873_2
16.6095	112.0600	14.8220	60.8205	1.10504_6	1.10505_0
16.6094	112.0548	14.8226	60.8209	1.10505_3	1.10505_7
22.9611	115.2032	19.9310	63.0132	1.14488_5	1.14488_9
28.2654	118.0699	23.9395	64.8004	1.17735_7	1.17736_2
29.6630	118.9756	24.9320	65.2531	1.18558_2	1.18558_7
29.6630	119.0305	24.9205	65.2484	1.18549_7	1.18550_2
30.8239	120.8316	25.5098	65.5183	1.19040_0	1.19040_5

left in the thermostat all night, final adjustment being made the following morning; whereas in all other determinations, both water and solutions, the pycnometer remained in the thermostat about an hour after its introduction.

The volume of the pycnometer at 25.01° is 55.0389 milliliters.

DETERMINATIONS ON SOLUTIONS OF SODIUM CHLORIDE

The complete data of the determinations are contained in table 2. In table 3, the slight changes necessary to reduce check determinations to the same per cent have been made. A curve through 0, 4.8250, 14.8220, and 24.9320 per cent has the following form, in which p represents per cent by weight:

$$D_p = 0.997\,071 + 0.007\,010\,9p + 0.000\,013\,268p^2 + 0.000\,000\,353\,5p^3$$

TABLE 3.—DENSITIES OF NaCl SOLUTIONS AT 25°, ALL CHECK DETERMINATIONS CORRECTED TO THE SAME CONCENTRATION

CONCENTRATION, PER CENT	$D_{4°}^{25°}$	FINAL VALUES $D_{4°}^{25°}$	CALCULATED VALUES, $D_{4°}^{25°}$	$D_{obs.} - D_{calc.} \times 10^6$
0.99673	1.00410_6	1.00410_6	1.00407_3	33
2.0210	1.01132_5	1.01132_5	1.01129_7	28
4.8250	1.03124_2	1.03124_7		0
	1.03125_1			
9.9955	1.06880_7	1.06880_9	1.06882_7	−18
	1.06881_0			
14.8220	1.10505_0	1.10505_2		0
	1.10505_3			
19.9310	1.14488_9	1.14488_9	1.14487_5	14
23.9395	1.17736_2	1.17736_2	1.17736_2	0
24.9320	1.18558_7	1.18559_2		0
	1.18559_7			
25.5100	1.19040_6	1.19040_6	1.19042_2	−16

TABLE 4.—DENSITY AND SPECIFIC VOLUME OF NaCl SOLUTIONS AT 25° AT ROUNDED CONCENTRATIONS

CONCENTRATION PER CENT	$D_{4°}^{25°}$				Sp. vol. MILLILITERS PER GRAM
	Hall	Bousfield	Baxter	Baxter	Hall
0.0	(0.997071)	(0.997071)	(0.997071)	(0.997071)	(1.00294)
0.5	1.00060_0	1.00061	1.00060	1.00055	0.99940
1.0	1.00412_3	1.00416	1.00412	1.00402	0.99589
2.0	1.01117_7	1.01122	1.01115	1.01102	0.98895
3.0	1.01825_0	1.01830	1.01817	1.01808	0.98208
5.0	1.03250_0	1.03250	1.03246	1.03234	0.96852
10.0	1.06884_2	1.06902	1.06881	1.06881	0.93559
15.0	1.10641_4	1.10663	1.10637	1.10648	0.90382
20.0	1.14543_8	1.14552	1.14539		0.87303
25.0	1.18615_7	1.18617	1.18608		0.84306

Column 4 of table 3 contains the values obtained from calculation with this equation; column 5 shows the difference between observed and

calculated values. A divergence curve, constructed on the basis of these differences, allows interpolations to be made with accuracy. In this manner, the figures of table 4, column 2, for our values at rounded concentrations have been obtained.

LIMITS OF PRECISION

The maximum divergence from the mean in the determination of the water content of the pycnometer was slightly more than 7 parts per million. In check determinations of the densities at four different concentrations, the greatest divergence from the mean was 5 parts in a little more than a million. Presumably the water content, the mean of five determinations, is accurate to 5 in the sixth decimal place; it therefore defines the limit of precision of the density determinations as the same figure.

Determinations on the density of sodium chloride solutions over the range of concentration and temperature presented here have been made by Bousfield[3] and Baxter,[4] the former at the temperatures 7°, 20° and 33°, the latter at 25° and other temperatures. Their values have been reduced to rounded concentrations by interpolation and by divergence curves, and are presented in columns 2, 3, and 4 of table 4. The reader is referred to the original articles for a critical consideration of methods employed and limits of precision. It should be noted, however, that the accuracy of the present work was enhanced by the very exact adjustments possible in the type of pycnometer used, and by the small changes in temperature to which the pycnometers were subjected.

The last column of table 4 contains the specific volumes in milliliters per gram at rounded concentrations calculated from the data of column 1.

SUMMARY

The densities and specific volumes of sodium chloride solutions at 25°C. and at concentrations up to 25.5 per cent are presented. They have been determined with an accuracy of 5 parts per million.

[3] BOUSFIELD and LOWRY, Trans. Far. Soc. **6**: 98–103. BOUSFIELD, Phil. Trans., Series A, **218**: 119–156. 1919.

[4] BAXTER, Journ. Amer. Chem. Soc. **33**: 912. 1911. **38**: 80. 1916.

ZOOLOGY.—Typhlops lumbricalis *and related forms.* DORIS M. COCHRAN, National Museum. (Communicated by Dr. L. STEJNEGER).

In 1920 K. P. Schmidt discussed[1] the status of the Porto Rican blind-snake, assigning to it the name *Typhlops richardii* Duméril and Bibron. He compared it with the Cuban form and found constant differences in scalation.

The collection of the so-called *Typhlops lumbricalis* in the National Museum had never been studied critically, and as this collection contains specimens from Guadeloupe, St. Thomas, Abaco, and Jamaica, localities which Schmidt did not include in his study for lack of specimens, a thorough examination of this material has seemed advisable.

The scale-counts of the six Porto Rican specimens in the National Museum bear out Schmidt's observations very well. He found that there were 22 scale-rows around the anterior portion of the body in the fourteen specimens at his disposal, and he counted 365 to 415 scales from the head to the tip of the tail. In my Porto Rican specimens I find the same number of scales around the body, while the minimum and maximum numbers in the longitudinal count are about 370 and 420. The four specimens from Jamaica in the National Museum have also 22 scale-rows around the body anteriorly, with a minimum and maximum count from head to tail of about 405 to 425 scales. Five specimens from St. Thomas, likewise with 22 scale-rows, have from 335 to 365 scales counted the length of the body.

It may be noted that the blind-snakes from these three islands—St. Thomas, Porto Rico, and Jamaica—have the same number of scale-rows around the body, while the number of scales counted from head to tail forms a graded series, the lowest count—335 to 365—coming from the easternmost island, St. Thomas, while Porto Rico, close by in a westerly direction, has from 365 to 420, and Jamaica, further still to the west, has a minimum count of not less than 405 and a maximum of 425.

The Cuban specimens examined by Dr. Schmidt had 20 scales around the anterior part of the body; on my larger series of 19 specimens I find the same number. From head to tail he counted 270 to 325 scales; on my series there are 255 to 340 scales. The three specimens from Santo Domingo in the National Museum have about 270 to 305, and 20 rows around the body, agreeing with the Cuban form in these respects. The single specimen from Abaco Island, one of the Bahama islands, mentioned by Cope[2]

[1] Ann. N. Y. Acad. Sci. **28**: 195. 1920.
[2] Proc. U. S. Nat. Mus. **10**: 439. 1887.

has a similar scale-formula—20 scale-rows, 260 scales the length of the body, 11 under the tail—and undoubtedly belongs to the same group.

An increase in the number of scales from head to tail, accompanying the westerly distribution, is to be noted likewise in this group of blind-snakes characterized by the possession of 20 scale-rows around the body. Those from Santo Domingo have no more than 270; those from the eastern end of Cuba have between 255 and 285; while from the western end (Havana and Pinar del Rio Provinces) there are between 270 and 320. Whether a large series of specimens will bear out these observations is a question to be settled by future collectors.

The single recorded specimen from Navassa Island, the type of Cope's *Typhlops sulcatus*,[3] has 20 scale-rows anteriorly around the body, and about 395 scales from head to tail. The suture extending from the nostril to the lateral edge of the rostral plate, which is present in snakes from all the other islands, is lacking in this specimen in spite of Cope's statement to the contrary. It is better to regard *Typhlops sulcatus* as a valid species until more material is received and the status of this form can be satisfactorily settled.

In regard to Dr. Stejneger's establishment[4] of the validity of *Typhlops dominicana* from the island of Dominica, a species characterized by the possession of 24 scale-rows and a very wide rostral, it is interesting to note that our five specimens sent by L. Guesde from Guadeloupe are undoubted examples of *T. dominicana*. The rows around the body are 24 in number, the scales from head to tail range between 400 and 440 in this series, and the rostral is noticeably very wide in every specimen.

The blind-snake found in Porto Rico and Jamaica must be called *Typhlops jamaicensis* (Shaw). The description of *Anguis jamaicensis* by Shaw[5] is based exclusively on the accounts of Browne and Seba. Shaw himself suspected that his "Jamaica slow-worm" was not the same as the Linnaean species, as he definitely questions the reference to *Anguis lumbricalis*. The comparison of the Jamaican species with the Cuban species having the low scale-count proves that his suspicion was well-founded.

In the use of the name *Typhlops lumbricalis* for the Jamaican blind-snakes Schmidt follows the example of Dumeril and Bibron, who considered that the Linnaean name of *T. lumbricalis* was based upon the Jamaican *Amphisbaena subargentea* of Browne. The facts, however, are as follows:

In the tenth edition of Systema Naturae[6] the characterization of *lumbricalis* is "230–7." The first reference given by Linnaeus under the name *lumbricalis* is the *Museum ichthyologium* of Gronovius, Tom. II, 1758, p. 52, no. 3, followed by a reference to Browne's *History of Jamaica* and to Seba's *Thesaurus*. The description by Gronovius of a specimen in his own col-

[3] Proc. Acad. Nat. Sci. Philadelphia **1868**: 128.

[4] Rep. U. S. Nat. Mus. **1902**: 687. 1904.

[5] Gen. Zool. **3**[2]: 558.

[6] **1**: 288. 1758.

lection is a very complete and satisfactory one, considering the time at which it was made. It begins with the polysyllabic name, "Anguis squamis abdominalibus ccxxx, et squamis caudalibus vii." This specimen with the small number of scales is therefore the one upon which Linnaeus bases his species *Anguis lumbricalis,* hence this name is applicable only to the blind-snakes with a small scale-count—those from Cuba, Santo Domingo and the Bahamas; consequently *T. richardii* must take its place as a synonym of *jamaicensis* Linnaeus took the reference to Browne's and Seba's works directly from Gronovius, but this quotation, of course, does not affect the fact that the specific name is based on a specimen with 237 scales from head to tip of tail. Even the name *lumbricalis* was suggested to him by Gronovius' comparison of this specimen with *Lumbricus terrestris*, the common earth-worm.

Duméril and Bibron described[7] a *Typhlops* collected by Plée and alleged to have come from Martinique. This species, *T. platycephalus,* having 20 longitudinal rows, 350 transverse rows on the body and 12 on the tail, was separated by them from *T. richardii,* having 20 longitudinal rows, 300 to 350 transverse rows, and about 15 on the tail, chiefly because their specimen of *T. platycephalus* had parietals much larger than the scales surrounding the ocular, which was not the case with their examples of *richardii.* In my six Porto Rican snakes I find that this relation is extremely variable, as the parietal in two of the specimens is distinguishable from the surrounding scales by its position alone, while in two others the parietal is about twice as large as the other scales bordering the eye posteriorly and superiorly. In the Cuban specimens I find the same great variability in the size of the parietal. With regard to the type-locality of *platycephalus,* Dr. Stejneger in the *Herpetology of Porto Rico* has shown[8] that the majority of Plée's specimens attributed to Martinique actually came from Porto Rico. As the number of rows around the body in Duméril and Bibron's specimen is given as 20, the count may have been made at the middle of the body, in which case the true maximum would not have been discovered. The number of scales from head to tip of tail, 350 plus 12, is within the limits of *jamaicensis.* The probability is that the type of *Typhlops platycephalus* came from Porto Rico; consequently it may be regarded as a synonym of *jamaicensis.* As Dr. Stejneger has shown[9] in his *Herpetology of Porto Rico* Boulenger's description[10] of what he supposed to be *Typhlops platycephalus* was taken from specimens in the British Museum at that time, which were all from Dominica, and which are now recognized under the name of *Typhlops dominicana* Stejneger.

[7] Erp. Gén. **6**: 293.
[8] Rep. U. S. Nat. Mus. **1902**: 557. 1904.
[9] Rep. U. S. Nat. Mus. **1902**: 687. 1904.
[10] Cat. Snakes Brit. Mus. **1**: 30.

The specimens of *lumbricalis* from Cuba, as well as all of the *T. jamaicensis*, have two postoculars between the parietal and the upper labials. In this respect they differ from the single Navassan and two Santo Domingan specimens, which have but one postocular. The third specimen has two small postoculars on one side of the head. The parietal scale in the Santo Domingan specimens is relatively larger than in either of the two Porto Rican specimens having large parietals. A large series of blind-snakes is needed to determine whether the single postocular and the extremely large parietal are characters sufficiently constant to warrant specific distinction for the Santo Domingan form.

The synonymy of the species is therefore as follows:

TYPHLOPS LUMBRICALIS (Linnaeus)

1758. *Anguis lumbricalis* Linnaeus, Syst. Nat. 10th ed., **1**: 288 (type-locality, America).
1830. *Typhlops cubae* Bibron, in Sagra's Hist. Fis. Pol. Nat., **4**: Rept., p. 122, *pl. 22* (French ed. p. 204) (type locality, Cuba).

TYPHLOPS JAMAICENSIS (Shaw)

1802. *Anguis jamaicensis* Shaw, Gen. Zool. **3**: 588 (type locality Jamaica).
1844. *Typhlops richardii* Duméril and Bibron, Erp. Gén. **6**: 290 (type locality St. Thomas).
1844. *Typhlops platycephalus* Duméril and Bibron, Erp. Gén. **6**: 293 (type locality, Martinique, Porto Rico).
1904. *Typhlops lumbricalis* Stejneger, Rep. U. S. Nat. Mus. **1902**: 684. 1904. (Porto Rico.)

TYPHLOPS SULCATUS Cope

1868. *Typhlops sulcatus* Cope, Proc. Acad. Nat. Sci. Philadelphia **1868**: 128 (type locality Navassa Island).

TYPHLOPS DOMINICANA Stejneger

1830. *Typhlops cinereus* Guérin, Icon. Régne Anim., Rept., *pl. 18, f. 2* (Guadeloupe) (not of Schneider, 1801).
1893. *Typhlops platycephalus* Boulenger, Cat. Snakes Brit. Mus. **1**: 30 (Dominica) (not of Duméril and Bibron, 1844).
1904. *Typhlops dominicana* Stejneger, Rep. U. S. Nat. Mus. **1902**: 687. 1904.

ZOOLOGY.—*On the value of nuclear characters in the classification of marine gastropods.*[1] WILLIAM H. DALL, National Museum.

The so-called nucleus in marine gastropods consists of the protoconch, the succeeding larval or nepionic coils, and sometimes a transitional part prefiguring the adult sculpture.

The primal protoconch in *Gastropoda* is a smooth cup gradually increased by growth into the summit of a spiral. It may be small or

[1] Published by permission of the Director of the U. S. Geological Survey.

large but its fundamental character is the same. The succeeding or nepionic portion of the nucleus may remain smooth, or take on sculpture, and in more specialized forms this sculpture may be greatly varied and exhibit numerous degrees of complexity.

The primal protoconch, at first of a horny consistency, in most cases is promptly calcified and remains permanently as the apical point of the nuclear portion of the shell. In many of the species from deep water it is more or less inflated or even mammillary. In others the nepionic part tends by acceleration to disappear, and features characteristic of the adult spire are more or less prefigured in the portion immediately succeeding the protoconch. In the Caricellinae of the Volutidae and possibly in the genus *Stilus* of the Cerithiopsidae, alone the protoconch seems to retain its original uncalcified texture and to be discarded before the nepionic shell leaves its ovicapsule, a trace of its original presence being left in the form of a sharp point where calcification began on the axis of the primal coil.

In a much smaller group of gastropods the nucleus remains permanently horny and usually of a brownish color contrasting emphatically with the succeeding calcified adult sculpture which follows by an abrupt transition.

This horny nucleus may remain without sculpture (*Dolium*); with spiral lines furnished with prominent dermal hairs (*Fusitriton*); of with sculpture of varied complexity. In the latter case the sculpture is most commonly an oblique reticulation, more or less fine, with a less evident fine spiral striation. Where the reticulation is coarse the interstices are more conspicuous and in worn specimens give a punctate effect to the surface. One set of the oblique threads may be stronger than the other, giving a ribbed look to the nepionic surface, or the oblique sculpture may be weaker, or even absent, while the spiral sculpture assumes prominence or concentrates into one or more carinae.

In common with most students of the mollusca for some years I have regarded the nucleus characters as more or less indicative of genetic affinity, but recently having had to work over large numbers of deep water species, especially toxoglossate forms, and to utilize Hedley's fine monograph of the Australian Turridae, I have found this view to involve so many apparently preposterous combinations of unlike things and separation of similar things, that I have come to the conclusion that this view cannot be maintained.

The simple smooth inflated protoconch as a modification of the original form is found among others to occur in the deep water species of the following very diverse groups:

TOXOGLOSSA

TURRITIDAE, CANCELLARIIDAE

RHACHIGLOSSA

OLIVELLIDAE, MARGINELLIDAE, FASCIOLARIIDAE, CHRYSODOMIDAE, COLUMBELLIDAE, MURICIDAE

GYMNOGLOSSA

MELANELLIDAE

TAENIOGLOSSA

TRIVIIDAE, TRIPHORIDAE, CERITHIOPSIDAE, TRICHOTROPIDAE, RISSOIDAE

Further search would doubtless add other families to this list.

The most common form of the horny nucleus with oblique reticulation was originally caught in the tow net and described as a genus *Sinusigera*, and I have therefore utilized the name by calling it the *Sinusigera* nucleus.

The form dehiscent in the ovicapsule can be denominated the *Caricella* nucleus. The smooth or nearly smooth form which occurs in the Tun and Helmet shells might be named the *Tonna* nucleus.

Lastly, the elevated, spirally ciliated form found in *Austrotriton* and probably in other *Cymatiidae*, can be named the *Triton* nucleus.

The following groups among others include species with horny nuclei:

TOXOGLOSSA

TURRIDAE

RHACHIGLOSSA

CARICELLINAE, MURICIDAE

TAENIOGLOSSA

TONNIDAE, CASSIDIDAE, CYMATIIDAE, TRIPHORIDAE, CERITHIOPSIDAE, TRICHOTROPIDAE

It is a material fact that no sedentary, parasitical, or exclusively littoral species is known to have a *Sinusigera* nucleus. Also that the inflated simple nucleus is found chiefly among species living in relatively deep water and becomes more general as we compare species of whatever genus from still deeper water. No instance is known to me where species with a well developed nucleus of this type has a floating larva.

The species with a *Sinusigera* nucleus, as far as known, float in the larval state, and the horny shell in cases where a suitable substratum is inaccessible sometimes reaches as many as seven whorls when it would normally have only half as many.

The horny shell destitute of limy coating is lighter than the calcified forms and thus adapted to the floating status. Carried by currents, genera having this type of nucleus are distributed widely. Those whose nepionic life is chiefly confined to the fluids in the ovicapsule, are comparatively restricted in range.

The conclusions indicated are that the differences above specified are due to adaptation for a floating larva or the reverse, and should not be regarded as genetically fundamental.

When two marine forms of similar anatomical structure exhibit different nuclei, I conclude that the adaptive modification is not of serious value in classification, and in most cases should not be considered as of more than sectional or subgeneric importance. The parallel occurrence of similar nuclei in widely different groups of families is obviously no indication of genetic affinity.

The variations in sculpture of forms deriving from the *Sinusigera* type, are probably, like the sculptural variations of the adult shell, of little more than specific value.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ENTOMOLOGICAL SOCIETY

358TH MEETING

The 358th meeting of the Entomological Society was held May 3, 1923, with Vice-President Böving in the chair and 35 persons present.

Program: G. F. WHITE: *Insect deseases.* The speaker gave a survey of the field of insect deseases, pointing out the different groups into which the causative agents are classified, the four main divisions of the study of insect pathology, and the qualifications that students of the subject should have. He showed that the field of the pathologist touches that of the bacteriologist, the protozoologist, the mycologist, the helminthologist, and the entomologist. It practically monopolizes a large portion of two other fields, those limited to filterable viruses and certain cell inclusions. The relative importance of the different phases was indicated graphically by diagrams.

J. M. ALDRICH: *A unique egg-laying apparatus in a tachinid fly.*

A. C. BAKER, *Recording secretary pro-tem.*

SPECIAL MEETING

A special meeting was held by invitation in the Laboratory of Bee Culture at Somerset, Maryland, May 23, 1923. Eighteen persons were present. The following papers relating to bee culture and the work of the Laboratory

were read: E. F. PHILLIPS: *Investigations in progress;* A. P. STURTEVANT: *The time of attack of the brood diseases;* E. L. SECHRIST: *Educational work of the Laboratory;* W. J. NOLAN: *Variation in brood population;* J. I. HAMBLETON: *Temperature measurements in the hive.*

Visits were then made to the following exhibits: temperature measurement apparatus and charts; photographic equipment for determining brood population; collection of samples of honey; *Acarapis woodii*, the cause of the Isle of Wight disease of bees; samples of the various brood diseases; spectro-photometer for measuring color of honey; charts showing variation in brood population throughout the season; drawings of honeybee anatomy by Snodgrass.

S. A. ROHWER, *Recording secretary pro-tem.*

359TH MEETING

The 359th meeting was held October 4, 1923, with President Howard in the chair and 64 persons present.

Program: L. O. HOWARD: *A recent trip to Europe.* The speaker attended the International Congress of Agriculture at Paris, the International Conference on the Olive Fly at Madrid, and the International Conference of Phytopathologists and Economic Entomologists at Wageningen, Holland. He also visited numerous institutions in England, France, Italy, and Belgium. This talk was illustrated by lantern slides, many of which showed European entomologists well known to members of the Society by correspondence and by their published works.

Dr. ALDRICH announced that *Braula coeca* Nitzsch, the so-called bee-louse of Europe, has been found in abundance in Maryland apiaries by Mr. Secrist, of the Bee-keeping Laboratory of the Bureau of Entomology. The species has been imported on queens before, a single specimen at a time, but was not known to be established until last month. Recent papers by Skaife[1] and by Arnhart[2] on the biology of the species are of great importance. From these it appears that eggs are laid on the comb, and the larvae make tunnels in the wax cappings of honey and brood cells; pupae were found in a brood comb, beside that of the drone in the same cell. Thus it appears that the insect is not pupiparous at all. Professor Bezzi recognized[3] this fact as early as 1916, when he placed the genus as a subfamily of Phoridae. The nearest relatives, in the opinion of Dr. Aldrich, are the wingless myrmecophilous and termitophilous Phoridae, although *Braula* may well be placed in a distinct family. Dr. Phillips said that apparently the insects do very little harm in the bee colony. They may congregate on queens, to which they are partial, but even this is rare.

Brief remarks were made by Drs. POSPELOV and BORODIN, of Russia, Dr. HUBRECHT, chargé d'affaires of the legation of The Netherlands, and Prof. G. A. Dean.

CHAS. T. GREENE, *Recording secretary.*

[1] Trans. Royal Soc. So. Africa **10**: 41–48. 1921.

[2] Zool. Anz. **56**: 193–197. 1923.

[3] Natura **7**: 174. 1916.

SCIENTIFIC NOTES AND NEWS

Invitations have been received by local societies to participate in the Third Pan American Scientific Congress, which meets at Lima, Peru, on November 16, 1924. It is desired that one or more official delegates be appointed to represent societies at this Congress. Members of the ACADEMY or of the affiliated societies who expect to be in Peru during November of this year are requested to communicate with some officer of the Academy.

The Secretary General of the Congress is Engineer José J. Bravo, Lima, Peru.

The Congress will comprise nine sections, as follows: (1) Anthropology, history, and related sciences; (2) Physics, mathematics, and related sciences; (3) Mining, metallurgy, economic geology and applied chemistry; (4) Engineering; (5) Medicine and sanitation; (6) Biology, agriculture, and related sciences; (7) Private, public, and international law; (8) Economics and sociology; (9) Education.

It will be recalled that the Second Pan American Scientific Congress sat in Washington from December 27, 1915 to January 8, 1916.

The Smithsonian Institution is assisting in the rehabilitation of Japanese libraries destroyed during the earthquake. Recently a shipment of 68 boxes of publications was sent to the University of Tokyo. This included a large number from the Library of Congress.

DR. T. NAKAI, of the Tokyo Imperial University, Government Botanist of Chosen, visited the Smithsonian Institution last month to study specimens of the Perry Expedition in the National Herbarium.

The Petrologists Club met at the home of F. E. WRIGHT on March 18, 1924. G. W. MOREY reviewed Niggli's book on *Die Leichtflüchtige Bestandteile im Magma*. W. F. FOSHAG spoke on *Genesis of minerals in lithophysae*, and C. S. ROSS on *Minerals in cavities of the volcanic rocks of the San Juan region*.

BENJAMIN A. COLONNA, an officer of the Coast and Geodetic Survey from 1870 to 1885, died in Washington on March 11, 1924, at the age of 80. He was promoted through all grades of the service, but was disabled by an accident while on field work in the Strait of Fuca, and never completely recovered his health. In recent years he had been engaged in private business in Norfolk and Washington.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 MAY 4, 1924 No. 9

MINERALOGY.—*Mullite, a silicate of alumina.*[1] N. L. BOWEN, J. W. GREIG, and E. G. ZIES. Geophysical Laboratory, Carnegie Institution of Washington.

INTRODUCTION

The compound $Al_2O_3 \cdot SiO_2$ occurring in the three forms sillimanite, andalusite, and cyanite has hitherto been regarded as the only compound of alumina and silica existing in nature. Of the three forms sillimanite has been accepted as the stable one under pyrogenetic conditions, but a recent study shows that it is necessary to make drastic modifications of existing conceptions in this regard. An investigation of the equilibrium relations of alumina and silica has shown that there is only one compound of these oxides stable in contact with liquid in the binary system.[2] This compound is $3Al_2O_3 \cdot 2SiO_2$ but crystals of it show such remarkable similarity with natural sillimanite that they have been identified with sillimanite by a number of workers examining synthetic mixtures and artificial products of various kinds.

The investigation noted above showed that this 3:2 compound is the only stable compound not only at the very high temperatures where liquid occurs in the binary system but also at temperatures as low as 1000°C. and probably much lower. In view of this fact it seemed to us that the compound could scarcely fail of occurrence in natural rocks though here again probably determined as sillimanite. The most promising material for the occurrence of the 3:2 compound

[1] Received March 10, 1924.

[2] Papers reporting the results of this investigation were presented by Bowen and Greig at the recent meetings of the Geological Society of America and of the American Ceramic Society. Journ. Amer. Ceramic Soc., April, 1924.

appeared to be the so-called sillimanite buchites or fused argillaceous sediments occurring rather frequently as inclusions in Tertiary intrusives of the Western Isles of Scotland. These have been noted by various writers, but those occurring in Mull have recently been the subject of a most interesting study in a paper by Dr. H. H. Thomas to whom we are greatly indebted for specimens of buchite.[3] It may be stated in advance that this material from Mull has fully justified our expectations.

The inclusions described by Thomas embrace the "sillimanite" buchites, which appear to be largely the product of direct fusion of phyllites, together with a number of varieties in which anorthite, hypersthene, and other minerals have been developed as a result of interaction of the inclusions and doleritic magma. It is the buchites proper that are of particular interest in the present connection. Of these we have examined two, one from Seabank Villa and the other from Nun's Pass. A chemical analysis of the latter is given by Thomas. The rocks consist principally of glass in which are embedded very rare plates of corundum and abundant minute prisms of a mineral having all the properties of sillimanite in so far as these can be measured in thin section. Careful measurements of the refractive indices of these crystals show, however, that the values are too low for sillimanite and, as will be shown more fully in the following, the crystals are to be identified with the compound $3Al_2O_3 \cdot 2SiO_2$. This compound has hitherto been recognized only in synthetic products. Its occurrence in natural rocks necessitates a mineralogical name and for this we propose the term, *mullite*, after the locality whence came the rocks in which it is here first identified, the Island of Mull.

PURE SYNTHETIC MULLITE

The pure compound $3Al_2O_3 \cdot 2SiO_2$ can be prepared by sintering a mixture of alumina and silica in the proportions demanded by the formula. A mass consisting exclusively of crystals of one kind is thus obtained, a fact which consitutes the best evidence of the composition of the compound. It is obtained also, together with other phases, in mixtures of alumina and silica in other proportions. In all these cases it has the same properties which are closely related to, yet distinct from, those of sillimanite. Comparison of their prop-

[3] *On certain Xenolithic Tertiary Minor Intrusions in the Island of Mull (Argyllshire).* Quar. Jour. Geol. Soc., **78**: 229–260. 1922. See also the fine new map. Geol. Survey Scotland, Mull, sheet 44, 3d edition, 1923.

erties is best given in tabular form (see Table 1) but, by way of emphasizing the similarity in those properties most readily determined, it may be stated that both form prisms of nearly square cross section with a perfect cleavage whose trace is parallel to the shorter diagonal of this section. The plane of the optic axes is parallel to this cleavage and the elongation of the prisms is positive. Only when we turn to properties to which definite numerical values can be assigned do the differences become apparent, and even then they are not very great. The sillimanite from Delaware County, Pennsylvania, with which mullite is compared is one that we selected as being particularly pure and of which an analysis is given in Table 3.

TABLE 1.—PROPERTIES OF PURE MULLITE AND OF SILLIMANITE

	MULLITE	SILLIMANITE*
Crystal system	Orthorhombic	Orthorhombic
Prism angle ($110 \wedge 1\bar{1}0$)	89° 13′	88° 15′
Cleavage	‖010	‖010
Optic orientation	c = γ and b = α	c = γ and b = α
Refractive indices γ	1.654	1.677
Refractive indices α	1.642	1.657
Axial angle, 2V	+45°–50°	+25°–30°

* The optical properties were measured on the sillimanite from Delaware County, Pennsylvania, of which an analysis is given in Table 3. The prism angle is that ordinarily given for sillimanite in the text-books.

Mullite was synthesized as long ago as 1865 by Sainte-Claire Deville and Caron.[4] They passed SiF_4 over a mixture of alumina and silica at a bright red heat and obtained crystals which had the composition given under I and II, Table 2. We have repeated the experiment and find that the crystals have refractive indices identical with those of pure mullite made by other methods.

Vernadsky separated crystals of mullite from Sèvres porcelain by means of hydrofluoric acid and analyzed the crystals. He found the composition given under III, Table 2. On the basis of these results he assigned the formula $11Al_2O_3 \cdot 8SiO_2$ to his own and to Deville's crystals.[5]

Cox separated the crystals from a burned fire clay and analyzed them with results given under IV and V, Table 2.[6] He accepts Vernadsky's formula.

[4] Ann. Chim. Phys. **5**: 114. 1865.

[5] Bull. Soc. Min. France **13**: 270. 1890.

[6] A. H. Cox, Geol. Mag. (Decade 6) **5**: 61. 1918.

All of these analyses agree in placing the composition somewhat more siliceous than the 3:2 ratio yet not so siliceous as the 11:8 ratio. In view of the fact that mullite crystals are particularly prone to carry small inclusions of the siliceous liquid in which they grow, this small excess of silica is probably not to be regarded as representing a real departure of the crystals themselves from the 3:2 ratio.

TABLE 2.—ANALYSES OF MULLITE BY EARLIER INVESTIGATORS

	I	II	III	IV	V	$3Al_2O_3 \cdot 2SiO_2$
	DEVILLE		VERNADSKY	COX		
SiO_2....................	29.1	29.5	29.7	30.07	28.89	28.2
Al_2O_3....................	70.9	70.2	70.3	69.93	71.11	71.8

TABLE 3.—COMPOSITION OF NATURAL SILLIMANITE

	I	II	III
SiO_2..	37.08	36.70	37.1
Al_2O_3..	63.11	62.73	62.9
Fe_2O_3..	0.09	0.63	
	100.28	100.06	100.0

I. Sillimanite from Delaware County, Pennsylvania. U. S. National Museum No. 9752. E. G. Zies analyst. TiO_2 is less than 0.01 percent.

II. Sillimanite from Romaine, Quebec.* E. W. Todd analyst.

III. Theoretical $Al_2O_3 \cdot SiO_2$.

* Walker and Parsons. Univ. of Toronto Studies, Geol. Series No. 16, 1923, p. 36.

MULLITE FROM SEABANK VILLA, ISLAND OF MULL

As we have already stated, the natural example of this compound, to which we wish to direct attention here, occurs as minute crystals embedded in glass. It would thus appear to be unfavorable material for the establishment of a species, but as a matter of fact it can readily be separated from the glass. This was accomplished by allowing the powdered buchite to stand over night in *cold* hydrofluoric acid which completely decomposes the glass without affecting the crystals (Vernadsky's method). After decanting the HF a little concentrated H_2SO_4 is added and the mass warmed to decompose fluorides. A little HCl is then added, followed by dilution with water. The remaining powder is then caught on a filter paper, well washed, and the filter paper burned off. In this manner a powder of a delicate lilac pink is obtained which proves on examination under the micro-

scope to consist of clean, sharp crystals of mullite with no foreign material other than very rare plates of corundum. The optical determinations and chemical analyses were made on powder so obtained.

The refractive indices of these crystals are higher than those of pure synthetic mullite, an effect to be attributed to their content of TiO_2 and Fe_2O_3, as is also their pink color. The determined values are given in Table 5, and in Fig. 1.

The chemical composition of this natural mullite is given in Table 4.

TABLE 4.—Analyses of Mullite

	I	II	III
SiO_2	28.2	29.04	29.36
Al_2O_3	71.8	69.63	69.05
Fe_2O_3		0.50	0.86
TiO_2		0.79	1.12
MgO			0.10
Na_2O		0.18	
K_2O		0.06	
	100.0	100.20	100.49

I. Theoretical composition $3Al_2O_3 \cdot 2SiO_2$.

II. Mullite from Seabank Villa, Island of Mull. (Contained 0.51 per cent corundum and 0.1 per cent rutile which were determined separately.) E. G. Zies analyst.

III. Mullite from the crowns of glass pots. N. L. Bowen, analyst. Fe_2O_3 and TiO_2 by M. Aurousseau.

The other buchite examined, the analyzed material from Nun's Pass, is not significantly different from the Seabank Villa example just discussed. Treatment with HF does not, however, yield as clean a product of mullite. A considerably greater quantity of corundum as well as rather abundant minute needles of rutile are left with the mullite. It was on this account that the product obtained from the Seabank Villa buchite was used for analysis, though, no doubt in the absence of better material, the composition of the mullite in the Nun's Pass buchite could have been determined by appropriate treatment. The refractive indices were measured, however, and found to be appreciably higher than those of the Seabank Villa mullite, in fact not significantly different from those of the pot-crown crystals immediately to be described.

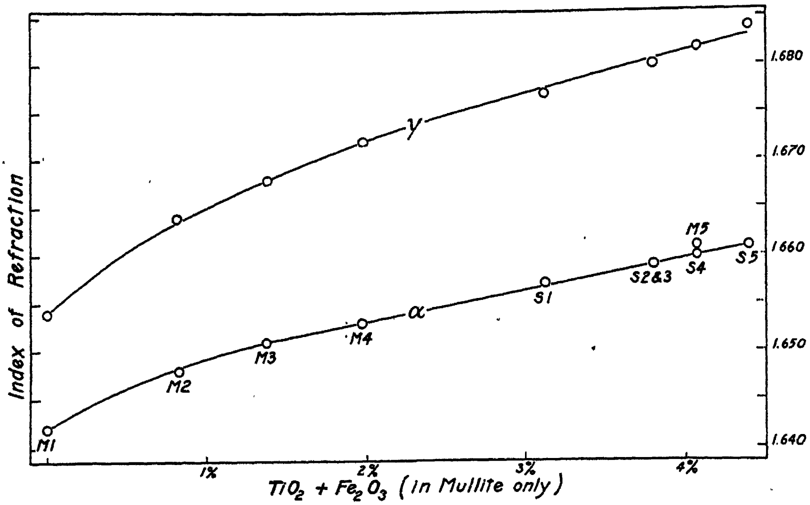


Fig. 1.—Relation between the refractive indices of various mullites and sillimanites. M1, M2, etc. = mullite I, mullite II etc. of Table 5. S1, S2, etc. = sillimanite I, sillimanite II, etc. of Table 6.

TABLE 5.—Refractive Indices of Mullites

	I	II	III	IV	V
γ	1.654	1.664	1.668	1.672	1.682
α	1.642	1.648	1.651	1.653	1.661

I. Pure mullite $3Al_2O_3 \cdot 2SiO_2$.
II. Eitel's crystals (made aluminothermically, exact composition unknown).
III. Natural mullite from Seabank Villa, Island of Mull. Analysis under II, Table 4.
IV. Mullite from pot crowns. Analysis under III, Table 4.
V. Mullite from glass pots (G. V. Wilson). Composition unknown.

TABLE 6.—Refractive Indices of Sillimanites

	I	II	III	IV	V
γ	1.677	1.680	1.680	1.682	1.684
α	1.657	1.659	1.659	1.660	1.661

I. Sillimanite from Delaware County, Pennsylvania. Analysis under I, Table 3.
II. Sillimanite from Romaine, Quebec. Analysis under II, Table 3.
III. Sillimanite from Morlaix, France. Exact composition unknown.
IV. Sillimanite from Saybrook, Connecticut. Exact composition unknown.
V. Sillimanite from Saybrook, Connecticut. Exact composition unknown.

MULLITE FROM THE CROWNS OF GLASS POTS

All wares made from clays develop mullite crystals when heated to a sufficiently high temperature. If the ware carries but little iron or titanium the mullite crystals approach pure synthetic mullite very closely in properties and therefore in composition. When much iron or titanium is present a considerable amount of these may enter into the mullite crystals with corresponding effect on their properties. Some material sent us by Mr. Donald Ross of the Findlay Clay Pot Company proved to be of the latter kind. It came from the crowns of covered pots used in the manufacture of glass during several months. The mullite crystals in this have refractive indices much higher than those of pure mullite but still appreciably lower than any sillimanite. A quantity of these crystals was separated from the glass matrix by the method already described and the clean crystals so obtained were used for determination of the refractive indices and for chemical analysis. It is to be noted that the crystals frequently contain minute tubular inclusions of the liquid (glass) in which they grew, which is highly siliceous, and these should tend to throw the composition of the analyzed sample a small distance on the silica side of the actual composition of the crystals. The results of analysis are given in Table 4. The crystals are plainly mullite containing considerable amounts of titanium and iron. Their optical properties are given in Table 5 and in Fig. 1.

OTHER EXAMPLES OF MULLITE CRYSTALS

Two other examples of mullite crystals will serve to complete the series. One of these was prepared by Eitel by an aluminothermic method. The crystals so obtained were believed to be sillimanite but careful measurement of the refractive indices by Eitel gave values much lower than those of sillimanite and only a little higher than those of pure mullite. The exact composition is unknown but observed pleochroism[7] indicates some content of TiO_2 and Fe_2O_3 and both γ and α fall at the same composition on Fig. 1, thus indicating a $TiO_2 + Fe_2O_3$ content very close to 1 per cent.

The other example was described by G. V. Wilson and comes from glass pots. Mr. Wilson has kindly sent us several specimens of glass-pot crystals and among these we find one lot of crystals whose refractive indices correspond exactly with those published by him. These indices are, as noted by Wilson, the same as those of silli-

[7] W. Eitel, Zeit. anorg. Chem. 88: 173. 1914.

manite from Saybrook, Connecticut, within the limits of error of measurement.[8] That these crystals are not sillimanite, however, we could state on the basis of the method of their formation alone, but we have also proved that they are not, in the absence of sufficient material for chemical analysis, by means of thermal tests which establish that they are mullite.

The refractive indices suggest a content of $TiO_2 + Fe_2O_3$ upwards of 4 per cent (see Fig. 1). The notably strong pleochroism is, no doubt, connected with the comparative richness in these oxides.

THE MULLITE SERIES

In the foregoing we have discussed individual members of a series of mullites of varying $TiO_2 + Fe_2O_3$ content. The series is best brought out in the plot of refractive indices against composition, Fig. 1. This plot emphasizes the remarkable convergence of the properties of mullite upon those of sillimanite as the $TiO_2 + Fe_2O_3$ content of the mullite increases, until finally the two are, for practical purposes, no longer distinguishable in crystallographic and optical properties. Chemical and thermal properties must then be resorted to. One exception is to be noted in the matter of optical properties, namely, that when mullite has indices close to those of sillimanite it is always markedly pleochroic with γ violet-pink, β and α colorless. Thomas remarks upon this unusual pleochroism in "sillimanite." Present indications are that it is characteristic of mullite. It should be noted that even the optic axial angle, which is quite large (45°–50°) in pure mullite, becomes smaller in other members of the series. In crystals of mullite with the higher amounts of $TiO_2 + Fe_2O_3$ it is sensibly the same as in sillimanite.

Several different sillimanites showing a range of indices have been placed on the plot and tabulated in Table 6. The variation of indices in sillimanite itself is no doubt connected with variation of content of $Fe_2O_3 + TiO_2$, but in only two of those given have optical properties and chemical composition been determined on the same material. These are the sillimanite from Delaware County, Pennsylvania, which is very near the theoretical composition, and that from Romaine, Quebec, which contains a greater quantity of Fe_2O_3 (see Table 3). The other sillimanites plotted have not been analyzed. The scale of $TiO_2 + Fe_2O_3$ given on the plot applies only to mullite and not, of course, to sillimanite.

[8] Trans. Soc. Glass Tech. 2: 189. 1918.

It cannot be too strongly emphasized that there is no transition in composition from mullite to sillimanite. Their remarkable similarity in crystallographic properties would lead one to expect a series of solid solutions but all crystals made in the laboratory or found in nature have been either the one or the other with nothing intermediate.

GENETIC ASPECTS

In the identification of mullite in these high-temperature contact rocks, buchites, the findings of the laboratory are confirmed. Mullite is the stable compound of alumina and silica at high temperatures. Present indications are that mullite will be found in other contact rocks particularly in those that have been strongly heated. When the limits of stability of mullite and sillimanite have been determined these minerals will, no doubt, prove useful temperature indicators in geology.

SUMMARY

Having found, in the course of an investigation of the system, alumina-silica, that $3Al_2O_3 \cdot 2SiO_2$ is the only compound stable at high temperatures, we anticipated that this compound would be found in rocks of the appropriate composition when formed at high temperatures. We therefore examined some sillimanite buchites, so-called, from the Island of Mull, kindly supplied us by Dr. H. H. Thomas, and found that the "sillimanite" is really the $3Al_2O_3 \cdot 2SiO_2$ compound for which we accordingly propose the name, *mullite.*

The optical properties of pure mullite have been determined, as well as those of a series of mullites of varying TiO_2 and Fe_2O_3 content mounting to about 4 per cent. The properties show a remarkable similarity with those of sillimanite, the members of the series highest in $TiO_2 + Fe_2O_3$ being practically indistinguishable from sillimanite in optical properties. Chemically, however, the two compounds, mullite and sillimanite are always distinct and in spite of their crystallographic similarity there is no solid solution series between them.

Mullite will, no doubt, be found in other rocks. Its presence in some rocks and that of sillimanite in others will afford useful information regarding the relative temperatures of formation of the rocks.

AGRICULTURAL CHEMISTRY.—*Measuring the potential alkalinity of irrigated soils.* C. S. SCOFIELD, Bureau of Plant Industry.

Certain irrigated soils are unproductive because of a bad physical condition which appears to be the result of the absorption of sodium from sodium salts in the soil solution. Unless the concentration of salts in the soil solution is relatively high, these soils are not readily permeable to the movement of water through them. When leached or digested successively with distilled water, small quantities of sodium pass into solution and impart to the solution an alkaline reaction.

It has been observed that when such a soil is treated with a soluble salt of calcium or aluminum some of the calcium or aluminum is absorbed by the soil from the solution, and the molecular equivalent of other bases, including sodium, is released into the solution. This replacement of one basic element by another is utilized in certain processes of "water softening" in which the calcium and magnesium in solution in the water are absorbed by the "zeolite" or "permutit" and the equivalent quantity of sodium passes into solution. An irrigated soil that is alkaline because of its content of absorbed sodium reacts like a water softening material when treated with a solution of a calcium salt.

This reaction of the replacement of a combined basic element of the soil by another basic element from a leaching solution applied to the soil makes it possible to measure the quantity of combined sodium, or, in other words, to measure the potential sodium alkalinity of a sample of soil.

EQUIPMENT AND METHOD

The soil to be tested is air dried, pulverized to pass a two-millimeter sieve, and then dried to constant weight at 105°C. A sample of 50 grams is then taken. The soil is placed in a cylindrical glass tube of one inch diameter and six inches in length. Each end of the tube is fitted with a perforated stopper through which is inserted one arm of a small glass tube which has been bent to V-shape. Each stopper is protected from the soil by a thin plug of absorbent cotton. The tube with its charge of soil is then clamped in a vertical position to a ring-stand.

A solution of calcium chloride having a concentration of M/80 (500 ppm. Ca) is placed in a large flask on a shelf three feet above the

laboratory table and connected to the tube leading to the bottom of the soil sample. The tube leading from the top of the soil sample is connected with a flask graduated for 250 cc. This flask is stoppered with a cork having two small perforations, one for the connection with the soil tube and one for the escape of the air replaced by the incoming liquid.

A pinch-cock placed on the connection between the soil tube and the bottle of leaching solution may be used to control the rate of inflow and to cut off the supply when the collecting flask is filled to the mark. With this set-up it is possible to leach a sample of soil in a slowly moving stream of the leaching solution, and at the same time protect the solution from increasing concentration through evaporation losses.

ANALYTICAL WORK

The leaching solution should be standardized with care by testing both for calcium and for chlorin. It is convenient also to measure its electrical conductivity if a bridge is available. The percolate should be examined for total salts, for calcium and magnesium, for sulphates, for the weak acids, carbonate and bicarbonate, as well as for chlorin. It is advisable also to test for nitrates and to make a quantitative determination if appreciable quantities are indicated.

INTERPRETATION

In comparing the analytical results from the percolate with the known composition of the leaching solution it is convenient to use the method of reacting values.[1]

Thus the leaching solution should contain r Ca 25 and r Cl 25. In the percolate the sum of the reacting values of the acids indicates the millimols of salts in solution. Those in excess of the r Cl 25 contained in the leaching solution show the soluble salt content of the soil. If the calcium content of the percolate is less than r Ca 25, this indicates that the difference has been absorbed by the soil. If magnesium is found in the percolate, it may have been replaced from combination with the soil or it may have existed as part of the soluble salts of the soil. The difference between the sum of the reacting values of the calcium and magnesium in the percolate and the sum

[1] PALMER, CHASE. *The geochemical interpretation of water analyses.* U. S. Geological Survey, Bull. 479, 1911.

of the reacting values of the acids identified affords a basis for estimating the reacting values of the alkaline bases, sodium and potassium. These may be determined quantitatively also, but since the analytical processes involved are somewhat tedious it is not usually done.

The potential alkalinity of a soil may be defined as the quantity of alkaline bases obtained in solution by leaching a sample of soil with a definite quantity of a standard solution of calcium chloride. The quantity of this alkalinity may be determined directly by analyzing the percolate for these alkaline bases or by taking the difference between the reacting values of the earthy bases, calcium and magnesium, found in the percolate and the sum of the reacting values of the acids which it contains. This potential alkalinity may be stated conveniently as a certain number of reacting units per 100 grams of soil. In the method described above the ratio of percolate to soil is as 5 to 1. The analytical results from the examination of the percolate should therefore be multiplied by 5 to convert the reacting values of the solution into reacting units per 100 grams of soil.

The following table shows the data obtained from a sample of 50 grams of an alkaline soil leached with a solution of r $CaCl_2$ 25 (M/80) to yield 250 cc. of percolate. The results are given both as per 100 cc. of solution and per 100 grams of soil.

Reacting Values

	Per 100 cc. of solution			Per 100 grams of soil
	Leaching	Percolate	Difference	Difference × 5
r Ca	25.0	13.0	−12.0	−60.0
r Mg	0.0	0.3	+0.3	+1.5
r earthy bases	25.0	13.3	−11.7	−58.5
r HCO_3	0.0	1.8	+1.8	+9.0
r Cl	25.0	26.5	+1.5	+7.5
r SO_4	0.0	0.7	+0.7	+3.5
r acids	25.0	29.0	+4.0	+20.0
r alkaline bases (by difference)	0.0	15.7	+15.7	+78.5

These results indicate that this sample of soil contained per 100 grams, 20 millimols of soluble salts and 78.5 units of alkaline bases or that its potential alkalinity was 78.5. It absorbed from the leaching solution, calcium equivalent to 60 units per 100 grams and gave up by replacement or solution 1.5 units of magnesium. It may be assumed that of the 78.5 units of alkaline bases obtained per 100 grams of soil, 20 units existed in the soil in soluble combination and 58.5 units in replaceable combination.

BOTANY.—*Further notes on Hispaniola ferns.*[1] WILLIAM R. MAXON, National Museum.

The present paper, which is in continuation of three published recently in this JOURNAL and the Proceedings of the Biological Society of Washington, relates to fern material on loan from the Berlin Botanical Museum and to specimens in the National Herbarium collected by Dr. W. L. Abbott and by E. C. Leonard in the Dominican Republic and Haiti, respectively. It includes descriptions of three new species, all from the Dominican Republic, and notes upon others that are rare or otherwise unknown from Hispaniola.

OPHIOGLOSSACEAE

Botrychium underwoodianum Maxon

Furcy, Haiti, *Picarda* 723b; *E. Christ* 1747. Morne la Selle, Haiti, altitude 2,000 meters, *E. Christ* 1851. Near Constanza, Dominican Republic, altitude 2,200 meters, *Türckheim* 3130.

Described from the Blue Mountains of Jamaica, and heretofore reported only doubtfully from Hispaniola. The present specimens, all in the Berlin Museum, are unmistakable, however. As in Jamaica, the period of maturity is August.

Botrychium jenmani Underw.

Valle Nuevo, near Constanza, Dominican Republic, altitude 2,100 meters, *Türckheim* 3130 in part.

New to Hispaniola. Described from the Blue Mountains of Jamaica, but since discovered also in Porto Rico and Cuba.

Botrychium obliquum Muhl.

Valle Nuevo, near Constanza, Dominican Republic, altitude 2,200 meters, *Türckheim* 3130b.

This species of the eastern United States has been known hitherto in the West Indies only from the Blue Mountains of Jamaica, where it is extremely rare on brushy stopes above 1,500 meters elevation.

MARATTIACEAE

Danaea urbani Maxon, sp. nov.

Plants delicate, the rhizome (incomplete) 1 to 1.5 cm. thick. Sterile fronds several, very lax, up to 60 cm. long; stipe as long as the blade, 2 mm. thick, deeply sulcate, with 2 or 3 narrow elongate nodes, dark olivaceous, finely streaked with reddish brown, deciduously brownish-paleaceous, the scales minute, suborbicular, peltate; blades lance-oblong, acuminate, imparipinnate, up to 30 cm. long and 12 cm. broad, obscurely alate, the wings expanded below the nodes; pinnae 10 to 12 pairs (the terminal one nearly conform), mostly inserted 1.5 to 2 cm. apart (the basal pair 3 cm. distant),

[1] Published by permission of the Secretary of the Smithsonian Institution.

oblique (45° to 50°), 5 to 8 cm. long, 11 to 14 mm. broad, linear or oblong-linear, inequilateral at the cuneate base (50°), long-acuminate or subcaudate in the apical fourth, stalked (2 to 3 mm.), subfalcate, the margins slightly revolute, subentire or repand-dentate in the lower half or two-thirds, beyond that sharply dentate-serrate, the teeth cuspidate; leaf tissue thin-membranous, translucent, sublustrous above, beneath much paler and bearing a few minute punctiform brown scales. Fertile fronds up to 75 cm. long, the stipe shorter than the blade, with 3 or 4 nodes; blades up to 30 cm. long and 7 cm. broad; pinnae about 15 pairs and a terminal one, stalked (2 to 5 mm.) the basal pair 4.5 cm. distant, all oblique, linear, 4 to 6 cm. long, 6 to 8 mm. broad, falcate in the outer part, the tip rather abruptly rounded-apiculate; synangia 50 to 60 pairs.

Type in the U. S. National Herbarium, no. 698,056, collected in Barahona Province, Dominican Republic, at 700 meters elevation, in moist woods, 1911, by Father Miguel Fuertes (no. 942). The data are partly taken from a sheet of the same collection in the Berlin Botanical Museum.

Distributed as *Danaea wrightii* Underw., a species of Cuba and Porto Rico, which differs in its heavier and strongly scaly stipe and rachis, its larger and thicker sterile pinnae, which are unequally rounded at base and merely acute to acuminate at apex, and its strikingly long-stalked fertile pinnae, these with half the number of synangia.

Immature specimens from Mount Morales, near Utuado, Porto Rico (*Britton & Marble* 1072), are referred to *D. urbani*, also; they differ only in having the pinnae slightly broader.

Marattia kaulfussii J. Sm.

Polo, Barahona Province, Dominican Republic, altitude 900 meters or above, *Abbott* 1830. Near Barahona, Dominican Republic, *Fuertes* 1432.

Both specimens have previously been referred[2] erroneously to *M. alata* Swartz, a species known to occur only in the high mountains of Jamaica and Cuba. Aside from the present record *M. kaulfussii* is known definitely only from South America.

POLYPODIACEAE

Hypolepis tenerrima Maxon, sp. nov.

Fronds weakly ascending, apparently up to 2.5 meters long, or more; rhizome slender, wide-creeping, with numerous coarse fibrous roots; stipe about 1 meter long, 4 to 5 mm. thick, distantly muricate, dark cinnamomeous or light castaneous from a brownish castaneous base, lustrous, glabrescent; blades 1.5 meters long or more, up to 1.5 meters broad, subtripinnate; pinnae slightly oblique, triangular-oblong to oblong-ovate, acuminate, up to 80 cm. long and 40 cm. broad, stalked (3 to 5 cm.), the secondary rachis cinnamomeous to light castaneous, glabrescent, distantly muricate or not; secondary pinnae distant, spreading (90°), lax, the basal ones a little reduced, the next 2 or 3 pairs the largest, narrowly oblong-lanceolate, long-attenuate, 16 to 20 cm. long, 5 to 7 cm. broad, the rachis stramineous to pale castaneous, lustrous, minutely puberulous; pinnules distant, spreading (90°), oblong or narrowly oblong, obtuse, those of the proximal side usually largest, 2.5 to 4 cm. long, 10 to 14 mm. broad, all but the smallest ones nearly pinnate,

[2] Proc. Biol. Soc. Washington 37: 98. 1924.

the segments joined by a narrow foliaceous wing; segments 7 to 11 pairs, slightly oblique, somewhat apart, oblong, rounded-obtuse, crenately lobed half-way to the middle (the lobes 2 or 3 pairs below the crenulate-dentate tip), scantily puberulous beneath, nearly glabrous above; veins delicate, mostly twice-forked within the lobes, the first anterior branch fertile, extending nearly to the deep sinus between the lobes; sori small, few-sporangiate (the receptacle small, elongate, slightly elevated), submarginal, subtended by a minute yellowish green, delicately membrano-herbaceous, indusiiform lobule, this concave or reflexed, glabrous, seated at the extreme sinus. Leaf tissue very delicately herbaceous, fragile, dull dark green on both surfaces.

Type in the U. S. National Herbarium, nos. 1,146,596–597, representing a complete pinna, collected in the vicinity of Paradis, Barahona Province, Dominican Republic, altitude 450 meters, January 30, 1922, by W. L. Abbott (no. 1619). Represented also by specimens collected at the same locality by Abbott (no. 1563) and by Fuertes (no. 1015), the latter determined by Brause as *H. hostilis* (Kunze) Presl.

The present species is almost certainly distinct from all described members of the genus, and, although only minutely indusiate, is perhaps nearest related to certain Brazilian plants that are still referred erroneously to *H. repens* (L.) Presl. Its most outstanding peculiarities are its extreme delicacy and the extraordinary fragility of its leaf tissue.

Hypolepis urbani Brause.

Loma Rosilla, La Vega Province, Dominican Republic, altitude 2,700 meters, July, 1912, *Fuertes* 1791b.

A study of the type material (2 sheets), lent from the Berlin Museum, necessitates some modification of the original description and a comparison with other species. Thus, the small lobules opposite the sori are not "unchanged," as stated, but are very definitely modified to thin, transversely linear-oblong, yellowish indusia of delicate texture, with fragile erose-dentate borders. *H. urbani* can not, therefore, be regarded as closely allied to *H. poeppigiana* Mett. It is much more closely allied to *H. bogotensis* Karst., which it suggests also in general aspect but from which it departs widely in its less ample indusia, thinner texture, and dense covering of minute pellucid hairs beneath. In the last respect it shows equal relationship to *H. viscosa* Karst.; but that species has a much coarser covering of distinctly glandular hairs, and indusia copiously fringed with long septate hairs.

Pteris hispaniolica Maxon, sp. nov.

Rhizome and stipe wanting; blade ternate; terminal branch wanting, presumably bipinnate; lateral branches bipartite, petiolate, the main division ovate, 55 cm. long, 25 cm. broad, the inferior division broadly ovate, 30 cm. long, 18 cm. broad, both fully bipinnate, abruptly long-acuminate, caudate, the rachises dull castaneous beneath, scabrous, scantily paleaceous, the scales dark brown, linear-attenuate, 2 to 3 mm. long, closely appressed, mostly caducous; pinnules oblique (45°), contiguous, subsessile, narrowly triangular-lanceolate, long-attenuate, 10 to 18 cm. long, 2.5 to 4 cm. broad at base, the rachis greenish-stramineous, scantily, laxly, and minutely brownish-paleaceous beneath and beset with numerous pale spines, these spreading or retrorse, mostly curved, nearly cylindrical, 0.4 to 0.6 mm. long; segments

distant (nearly or quite their own width apart), oblique, mostly simple (the basal ones sometimes enlarged and pinnatisect), linear, semiadnate, decurrent, lightly falcate, up to 2.5 cm. long, 3 to 4 mm. broad, acutish at apex, the tip whitish-cartilaginous, mucronate; margins of sterile segments rigidly recurved, cartilaginous, rigidly incurved-serrate toward the tip, the firm whitish border joining the enlarged whitish arcuate vein-ends throughout; costae prominent, sulcate, and glabrous above, very strongly rounded and elevated beneath, sparingly septate-fibrillose at base and bearing a few blunt spines; veins 10 to 13 pairs, oblique, mostly once forked near the costa, evident above, beneath thick, whitish, broad, slightly elevated, glabrous; leaf tissue very rigidly herbaceo-coriaceous, grayish green and sublustrous above, paler beneath; indusia ample, about 0.8 mm. broad, not reaching the tip, abruptly discontinuous, firm, whitish, brownish with age.

Type in the Berlin Botanical Museum, collected on Morne de la Hotte, Département du Sud, Haiti, at 1,400 meters altitude, August 7, 1917, by E. L. Ekman (no. 525). A second specimen from Haiti (Mission, altitude 1,200 meters, *Leonard* 3900) represents what may be an atypical juvenile form of the same species; in this the segments are mostly sessile or even short-stalked, but in minute characters it is identical.

The relationship of *P. hispaniolica* is with *P. coriacea* Desv., as which it was determined by Brause. From that species it differs notably, however, in its gray-green (not strongly yellow-green) color, and its oblique, linear, distant, semiadnate segments, the segments of *P. coriacea* being relatively much broader, close together, and wholly adnate. The rachises of the pinnules are strongly flexuose in *P. coriacea*, but not at all so in *P. hispaniolica*.

Polypodium jenmani Underw.

Morne de la Hotte, Haiti, altitude 800 meters, *Ekman* 153.

New to Hispaniola, having been known heretofore only from Jamaica and Cuba.[3]

Polypodium arcuatum Moritz.

Loma Rosilla, La Vega Province, Dominican Republic, altitude 1,300 meters, in wet forest, *Fuertes* 1781.

The specimens, so determined by Brause, afford an interesting extension of range for this species, which has been known only from South America. It may now be reported from Jamaica, also, on the basis of the following specimens, all from the vicinity of Vinegar Hill, altitude 1,200 meters: *Hart* 169; *Underwood* 2597; *Maxon* 1524, 2778, 2786.

Polypodium plesiosorum Kunze.

Las Lagunas, Azua Province, Dominican Republic, altitude 1,000 meters, *Fuertes* 1854.

Apparently new to the West Indies; agreeing fairly well with some of the Mexican and Central American material referred to this species.

Polypodium surucuchense Hook.

Loma Rosilla, La Vega Province, Dominican Republic, altitude 1,300 meters, *Fuertes* 1770. Near Constanza, Dominican Republic, altitude 1,300 meters, *Türckheim* 3220.

[3] Journ. Wash. Acad. Sci. 12: 440. 1922.

This species in one form or another occurs on the continent from Guatemala to the Andes of Ecuador. In the West Indies it has been known previously from Jamaica, Martinique, and Guadeloupe.

Oleandra guatemalensis Maxon.

Morne de la Hotte, Haiti, altitude 1,400 meters, on decayed tree trunks, *Ekman* 547.

The specimen at hand, lent from the Berlin Museum, is the type of *O. urbani* Brause. It is in no way distinguishable from *O. guatemalensis*, known otherwise only from Guatemala.

Dryopteris linkiana (Presl) Maxon.

Gymnogramma diplazioides Desv. Mém. Soc. Linn. Paris **6**: 214. 1827.
Dryopteris diplazioides Urban, Symb. Ant. **4**: 21. 1903, not Kuntze, 1891.
Gymnogramma polypodioides Link, Hort. Berol. **2**: 50. 1833, not Spreng. 1827.
Grammitis linkiana Presl, Tent. Pter. 209. 1836.
Nephrodium linkianum Diels in Engl. & Prantl, Pflanzenfam. 1^4: 172. 1899.

Mission, Fond Varettes, Haiti, in thickets on mountain slopes; occasional, *Leonard* 4001.

This species was described originally from Haiti, but seems to have been known otherwise from Hispaniola only upon the basis of a specimen in the Copenhagen Herbarium, collected by Thouin. The present specimen has a slender erect rhizome more than 15 cm. long and leaves 145 cm. long; the blade has 6 or 7 pairs of greatly reduced basal pinnae, the lowermost merely vestigial.

Under the American Code the name *Dryopteris diplazioides* (Desv.) Urban, 1903, is not available for this species, the same combination having been proposed by Kuntze in 1891 for the very different plant of Venezuela described in 1858 as *Aspidium diplazioides* Moritz. Only the essential synonymy is given above.

SELAGINELLACEAE

Selaginella lasiophylla A. Br.

Summit of Loma Atravezada, at base of Punta Cabrón, Samaná Peninsula, Dominican Republic, altitude 600 meters, *Abbott* 2941.

Apparently new to Hispaniola. The identification is by comparison with a specimen from Troy, in the "Cockpit" region of western Jamaica (*Maxon* 2845), so determined long ago by Hieronymus. The species is unusual in its delicately scabrid-setulose leaves.

Selaginella longispicata Underw.

Mao, Santiago Province, Dominican Republic, altitude 100 to 300 meters, *Abbott* 1035.

A remarkable extension of range for this species, which has been known hitherto only from Yucatán. The specimens offer no special points of distinction from Yucatán material, of which the following specimens are at hand: *Gaumer* 825 (3 sheets); *Valdez* 50; *Schott* 669.

ZOOLOGY.—*New genus and species of South American snakes contained in the United States National Museum.* AFRANIO DO AMARAL, Inst. Butantan and Mus. Paulista, S. Paulo, Brazil. (Communicated by L. Stejneger).

A careful study recently made of a large number of unidentified South American snakes contained in the United States National Museum has afforded me the opportunity to find several forms which appear to be new to science.

Acknowledgment is hereby extended to Dr. L. Stejneger and Miss D. Cochran for inviting me to identify the collection and for their kind assistance throughout my study.

Rhadinaea albiceps, sp. nov.

Head slightly distinct from neck; snout short, moderate. Maxillary teeth increasing in size posteriorly; mandibular teeth subequal. Rostral nearly twice as broad as deep, scarcely visible from above; internasals small, half as long as the praefrontals; frontal a little longer than broad and longer than its distance from the end of the snout, shorter than the parietals; nasal divided; loreal a little longer than deep; one praeocular not reaching the upper surface of the head; one small subocular below the praeocular; postoculars 2, the lower very small; temporals 1 + 2; upper labials 8, the 4th and 5th entering, the orbit; 1st lower labial in contact with its fellow behind the symphysial, the 5 lower labials contiguous to the anterior chin-shields which are a little longer than the posterior. Scales smooth, without pits, in 17 rows. Ventrals 121, rounded laterally; anal divided; subcaudals 122 pairs.

Seal brown above, with two whitish stripes on each side, the outer running from the side of the nape to the tip of the tail on the 1st row of scales, the inner, not so marked, running only up to middle of the tail on the 5th row of scales; head whitish up to the occiput, with a brown spot between the anterior temporal and the 7th upper labial; whitish yellow beneath; sides of the ventrals brown.

Type: Adult ♂, no. 22,446 in the collection of the U. S. National Museum, sent, probably from Ecuador, by Mark B. Kerr, in May, 1895.

Total length 350 mm.; tail 154 mm. (3/7 of the total).

This species is closely allied to *R. decorata* (Gthr.), from which it differs in coloration and in the proportional size of the chin-shields. Its dorsal markings are like those of *Erythrolamprus labialis* Werner,[1] from Ecuador.

Sibynomorphus macrostomus, sp. nov.

Body slender, laterally compressed; head somewhat distinct from neck; pterygoid teeth present; eye large. Rostral broader than deep, scarcely visible from above; internasals half as long as the praefrontals; frontal hexagonal, a little longer than broad and longer than its distance from the end of the snout, shorter than the parietals; nasal entire; loreal large, a little longer than deep; no praeocular; postoculars 2; temporals 2 + 3; upper labials 10/11, the 4th, 5th, 6th, and 7th entering the orbit; 1st lower labial in contact with

[1] Werner. Über n. o. s. Rept. d. nat. Mus. Hamburg, 1: 237. 1909.

its fellow behind the symphysial; 4 pairs of chin shields, anterior longer than broad, others subequal. Scales in 15 rows, vertebral moderately enlarged; ventrals 204; anal entire; subcaudals 98 pairs.

Clove brown with 34 cream-buff annuli which sometimes show small brown spots; head clove brown; occiput, lips, and throat cream-buff, irregularly spotted with brown.

Type: ♀, no. 14,047 in the collection of the U. S. National Museum, caught in Ecuador by Dr. Wm. H. Jones and sent with other snakes to Prof. Cope in July, 1886.

Total length 240 mm.; tail 63 mm.

This is allied to *S. hammondii* (Blgr.),[2] *gracilis* (Blgr.),[3] and *palmeri* (Blgr.),[4] which also are from Ecuador, *S. articulatus* (Cope),[5] type from Costa Rica, *S. barbouri* Amaral,[6] type from Alagoas, Brazil, and *S. peruanus* (Boettger),[7] type from Peru. It differs from *hammondii* and *gracilis* in having a higher number of temporals, upper labials, and chin-shields, a lower number of subcaudals, and many more light rings on the body; from *palmeri* in having a higher number of upper labials, chin-shields, and ventrals; from *articulatus* in having a higher number of upper labials (only three labials enter the orbit in *articulatus*) and a lower number of subcaudals; from *barbouri* in coloration and in having a higher number of upper labials; and, finally, from *peruanus* in coloration and in having a higher number of upper labials, ventrals, and subcaudals.

Barbourina, gen. nov.

Head slightly distinct from neck; eye moderate, with vertically elliptical pupil. Maxillary teeth 8, subequal, followed, after a short interspace by a pair of sword-like, moderately enlarged grooved fangs, situated just behind the vertical of the posterior border of the orbit; mandibular teeth small, subequal. Body cylindrical; scales smooth, without pits, in 17 rows, vertebral enlarged throughout the body, about one and one-third as broad as long. Tail moderate; subcaudals in two rows.

Barbourina has the same general physiognomy of *Pseudoboa* Schneider, 1801, from which, however, it may be separated by the dorsal pholidosis and the dentition.

It is named in honor of Thomas Barbour, the distinguished herpetologist of the Museum of Comparative Zoology.

Barbourina equatoriana, sp. nov.

Snout round and scarcely projecting. Rostral a little deeper than broad, its portion visible from above equal to 1/3 its distance from the frontal; internasals twice as broad as long, half as long as the praefrontals; frontal a little longer than broad and longer than its distance from the end of the

[2] Boulenger. Ann. Mag. Nat. Hist. **6**: 110. 1920.
[3] Boulenger. Ann. Mag. Nat. Hist. **9**: 57. 1902.
[4] Boulenger. Ann. Mag. Nat. Hist. **10**: 422. 1912.
[5] Cope. Proc. Acad. Nat. Sci., Philadelphia. **1868**: 135.
[6] Amaral. Proc. N. E. Zool. Club. **8**: 92. 1923.
[7] Boettger. Kat. Rept. Mus. Senckenb. **2**: 128. 1898.

snout, a little shorter than the parietals; nasal entire, in contact with the praeocular (on the right) which does not reach the upper surface of the head; no loreal; 2 small postoculars, subequal; temporals 2 + 3; 7 upper labials, the 3d and 4th entering the orbit; 2d touching the praefrontal on the left; 1st lower labials in contact with its fellow behind the symphysial; 4 lower labials in contact with the anterior chin-shields which are a little longer than the posterior. Scales in 17 rows. Ventrals 204, rounded laterally; anal entire; subcaudals 75 pairs.

Pinkish-yellow (red?) above, all the scales tipped with black; head brown above, with a yellowish-white band occupying the parietals, temporals, the 3 posterior upper labials, and the occiput, and followed by a dark blotch on the nape; chin dark; throat and lower surface of the body and tail yellowish-white.

Type: ♂, no. 62,790 in the collection of the U. S. National Museum sent from Guayaquil, Ecuador, by F. W. Goding, in April, 1920.

Total length 300 mm.; tail 60 mm.

Elapormorphus suspectus, sp. nov.

Rostral as deep as broad, the portion visible from above 2/3 as long as its distance from the frontal; internasals broader than long, their suture half as long as the single praefrontal; frontal one and half times as long as broad, a little shorter than its distance from the end of the snout, much shorter than the parietals, which are more than twice as long as broad; praeocular 1, in contact with the entire nasal; postoculars 2; temporals 1 + 1; upper labials 6, the 2d and 3d entering the orbit; 4 lower labials in contact with the anterior chin-shields, which are a little longer than the posterior. Scales in 15 rows. Ventrals 212; anal divided; subcaudals 31 pairs.

Pale brown above, speckled with black, with a black narrow punctuate vertebral line, and a broad black lateral band from the side of the neck to the tip of the tail, covering the 4th and the lower half of the 5th scale rows; the 3 rows of scales below this band entirely yellowish-white; head dark brown above, with a yellow, black-edged occipital collar; lower lip spotted with dark brown; ventrals black, light-edged; a black bar across the base of the tail; lower surface of the tail yellowish-white with a black narrow line along the middle.

Type: ♂, no. 48,939 in the U. S. National Museum, collected in Pilár, near Córdoba, Argentina, by Dr. C. C. Craft, and received on May 15, 1912.

Total length 308 mm.; tail 28 mm.

This species is closely allied to *E. lemniscatus*, from which it differs greatly in coloration.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ENTOMOLOGICAL SOCIETY

360TH MEETING

The 360th meeting was held November 1, 1923, with President Howard in the chair and 32 persons present.

Program: R. E. SNODGRASS: *Insect musicians, their music and their instruments.*

Every year there is a regular program of insect music, beginning the latter part of May or the first of June with the chirps of that group of *Gryllus assimilis* that winters in a nymphal stage. Later, about the first of July, the tree crickets mature and their commingled notes from now on form that continuous sound heard every night till cold weather. Against this background the notes of other species are heard rather as individual songs than as parts of the general chorus. These include the notes of the various members of the katydid family and those of other crickets. The true katydid is generally found only in undisturbed woods and is not commonly a member of the dooryard troupe either in town or in open country places.

The daylight singers include the cicadas, a few of the grasshoppers, and many species of katydids and crickets that sing both by day and by night.

The principal singing insects belong to three families of the Orthoptera, the Acrididae, the Tettigoniidae, and the Gryllidae, and to the Cicadidae of the Hemiptera. Many others make squeaking or rasping sounds of various sorts, but they are not often heard.

The grasshoppers or locusts (Acrididae) make their notes by scraping the hind femora over the tegmina. The katydids (Tettigoniidae) and the crickets (Gryllidae) produce their sounds by rubbing over each other the basal parts of the wings on which are situated the stridulating organs. In the katydids the file is usually developed on the left wing only and these insects always keep the left wing uppermost. The crickets, on the other hand, usually keep the right wing uppermost, though the file is equally developed on each wing. Exceptions occur in *Gryllus assimilis*, some individuals of which are "left handed."

The cicadas produce their notes by special tympana situated on the sides of the first abdominal segment, which are set into vibration by special muscles. The sound is reinforced by the great air chamber of the abdomen and by membranes on the lower part of the first abdominal segment.

There is not sufficient evidence at hand to substantiate the common idea that the song of the male insect is in itself attractive to the female or that the singing of the male is directly excited by a desire for the female. The sound of the singing probably lets the female know the whereabouts of the male, but, in some of the crickets at least, the female is lured to the male by a liquid exuded on the back of the metathorax of the male while he is singing. On the other hand common observations furnish evidence that male crickets sing when they are not in a matrimonial mood, and at times when the presence of the female is even an annoyance to them. The presence of another male is a much surer excitation to song than the presence of a female. (*Author's abstract.*)

A. G. Böving: *The historical development of the term "triungulin."* The first instar of blisterbeetles has been known far back in the past. Goedart in 1667 and Frises in 1727 described and correctly determined it. Linnaeus and Raaumur, however, took it as an apterous insect, placed it in the genus *Pediculus*, and named it *Pediculus apis*. Fabricius followed Linnaeus, but deGeer, who reared it from eggs, plainly stated that *Pediculus apis* L. is a first instar Meloid-larva. Since then several authors at different times have confirmed his statements as to the origin of the parasite. It is however interesting to note that many of the most prominent entomologists repeatedly took reservations, and by pure speculation maintained the idea that it belonged to the apterous hexapods. Among those are Kirby (1802) and Dufour, who in 1828 carried the idea of Linnaeus and Kirby one step further,

classifying the parasites in a distinct genus *Triüngulinus* between *Pediculus* and *Racinus;* and almost one hundred years from the time of Reaumur Westwood still upholds the faulty interpretation. Through Serville's, and especially Newport's, investigations the more than hundred-year old discussion was settled in favor of the first discoverer and describer of the natural history of the blisterbeetles, Goedart.

Since Dufour proposed the name *Triungulinus* for what he considered as a genus of Aptera the first instars of Meloid larvae have often been called triungulins. This name, however, is not suitable, partly because only a small minority of Meloid larvae have the characteristic armature of three claws at the end of the tibia, partly because this armature really is to be interpreted as a single median claw-shaped or spathulate tarsus with two strong setae laterally at base, and partly because the triunguline armature is not restricted to larvae of the family Meloidae but lately has been found also in a larva of the family Lampyridae, collected by Dr. Mann in Bolivia in 1921 and now preserved in the National Museum. Newport and Fabre never use the term "triunguline," but always the term primary larva for the first instar of Meloid larvae, and the greatest living authority on that family, Dr. A. Cros, has adopted this same term, and in a special very interesting article (1917) set forth how inadvisable the continued usage of the term "triungulin" is.

Dr. M. C. Hall, Bureau of Animal Industry: *Lesions due to the bite of the wheel-bug,* Arilus cristatus *(Hemiptera; Reduviidae).* In the fall of 1922, the writer's youngest daughter (M. L. H.) aged 10, captured a wheel-bug, *Arilus cristatus* (determined by W. L. McAtee), at Chevy Chase, D. C., and was bitten twice by it on the inner aspect of the little finger of the right hand at a point near the nail. The bite was painful, about as much so as a bee sting, according to the child, and the finger felt hot to the touch. In the course of a few days growths resembling papillomata developed at the site of the punctures, the largest projecting as a small horn-like structure. Both of the growths persisted for months, the largest slowly disappearing between six and nine months after the infliction of the bite. The injured finger remained warmer than the other fingers during this period and, according to the patient, still feels warmer than the others a year later. The development of pronounced cutaneous growths after a bite appears not to have been reported as following the bite of members of the Heteroptera. Previous reports show that there may be transient or prolonged local inflammatory reactions at and near the site of the injury and more or less severe general reactions lasting a short time or persisting for almost a year.

Over 30 species of Heteroptera have been reported as attacking man, and probably many more than 30 attack man occasionally. At least 9 genera are reported as attacking man in North America; these genera include *Cimex, Opsicoetes* (Reduvius), *Apiomerus, Triphleps, Arilus* (the present note), *Conorhinus, Rasahus, Melanolestes,* and *Reduviolus.*

Dr. Schwarz said that he thought the wheel-bug bite was more painful than the sting of the honey-bee because the pain lasted for several days.

Dr. Ball said that he had received a bite on his finger from a water-bug, the effects of this bite lasting for 6 weeks.

Chas. T. Greene, *Recording secretary.*

SCIENTIFIC NOTES AND NEWS

On account of the separation of Esthonia from Russia, the Russian University of Dorpat was transferred to Voronesh at the end of the year 1918, while an Esthonian University was founded at Dorpat. The University of Voronesh at present consists of four Faculties: Medicine, Physics and Mathematics, Pedagogy, and State-Sciences. The Faculty consists of 650 members and the number of students in attendance is 5000. The University is handicapped by the loss of the old Library, and although a large number of books have been collected for the new library, there are many missing numbers of various journals. The University publishes the Acta Universitatis Voronegiensis and is desirous of entering into exchange with Societies and Institutions. Communications may be addressed to the State University, Voronesh, Russia, or to its representative, Mr. W. Breitfuss, Berlin W. 30, Gleditschstrasse, 40 I, Germany.

The new building of the National Academy of Sciences and National Research Council, at Twenty-second and B streets, near the Lincoln Memorial was dedicated on Monday, April 28, during the meetings of the Academy.

Dr. F. HASTINGS SMITH, of the Geophysical Laboratory, left Washington in April to spend a year in England and continental countries. In October, he will attend the meetings of the International Union of Geodesy and Geophysics at Madrid.

L. W. STEPHENSON of the U. S. Geological Survey has returned from South America, where he has been engaged in private work for six months.

WILLIS T. LEE has been granted leave of absence for the rest of the year from the Geological Survey and will make a detailed study of the Carlsbad Cave in Arizona for the National Geographic Society.

KENNETH C. HEALD, chief of the oil and gas section of the Geological Survey, has been appointed associate professor of Geology at Yale University with assignment to the Sheffield Scientific School. He will continue his work for the Geological Survey until next September.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 MAY 19, 1924 No. 10

AGRICULTURAL CHEMISTRY.—*The active acidity of soils.*[1] EDGAR T. WHERRY, Bureau of Chemistry.

In a solution of an acid substance, part of the acid exists in molecular form and is not capable of producing directly the effects attributable to acids; but another part is ionized, that is, separated into electrically charged portions, and one of these portions, namely the positively charged hydrogen, known technically as hydrogen-ion, is the immediate cause of most acidity phenomena. Some writers have classed the portion of the acid thus ionized as "actual," "real," or "true" acid. Such terms are, however, inappropriate, for chemical compounds are just as "real" as are atoms or ions; and descriptive adjectives like "active," "effective," or "potent" are much to be preferred. The first of these seems least likely to be misunderstood, and is therefore used here. "Active acidity," then, signifies acidity due to positively charged hydrogen ions. Correspondingly, "active alkalinity" is that due to negatively charged hydroxyl or (OH) groups. Titration measures not only the active but also the non-ionized acid or alkali; in other words, titrable acidity or alkalinity correspond to the *total* acid or alkali. The *active* acid and alkali, which affect directly the growth of plants and other phenomena of importance in agriculture, however, are, in the light of recent developments, of the greater significance.

That agricultural soils can become sour or acid and as a result act unfavorably on the growth of certain crops has long been recognized, and many methods have been proposed to ascertain the degree of acidity attained in a given case, the more important of which may be summarized as follows:

[1] This paper was presented in preliminary form at a symposium on *Relation of soil acidity to classification*, held by the American Association of Soil Survey Workers, in Chicago, September, 1923. It was distributed in mimeographed form in the proceedings of that meeting. The present revision presents a better statement of the writer's views.

1. The growth of weeds is observed.
2. Lime-requirement is determined,
   A. By adding a solution of a salt, and determining the resulting acidity by titration or other means.
   B. By direct titration with lime water.
3. Pure water is added to the soil, and the active acidity is measured:
   A. Electrometrically.
   B. Color-comparatively.

1. *The growth of weeds is observed.*—The farmer is accustomed to accept the appearance in a field of sorrel (*Rumex acetosella*), of certain grasses, such as beard-grass (*Andropogon spp.*) or of almost any kind of moss as a sign that the soil is becoming "sour." The writer has made a number of tests of the active acidity present under such circumstances, and has found that these indications are not dependable. Sorrel, beard-grass, and many species of moss, while they admittedly do grow frequently in soils which have really become acid, also thrive luxuriantly in soils which from the chemist's point of view are not acid at all, but are distinctly, or even rather strongly, alkaline. It is possible that these plants really indicate a diminution in the amount of available nitrogen in the soil, for they may have some means of obtaining nitrogen not possessed by ordinary crop plants. Lime might benefit such soils, then, not because of its neutralization of any acidity, but because in some other way it favors the growth of nitrifying organisms; but when the "sour" soil already contains sufficient calcium to satisfy these organisms, the liming will not produce any effect at all.

It is concluded, accordingly, that observation of weeds is an unsafe basis for diagnosing the presence of active acidity, and that the farmer's term "sour" means nitrogen-poor, and not acid at all.

2. A. *Lime requirement is determined by adding a salt solution and titrating.*—The significance of the "lime-requirement" methods in which salts are added to the soil has already been discussed by the writer[2] but may well be stated here in a new form. The salt is believed to react with the soil colloids in the following manner:

$$KNO_3 + HX \rightleftharpoons KX + HNO_3.$$

Here X is used to represent the colloidal matter in the soil, which possesses some acid properties, although these are modified by its slight solubility. On the other hand the nitric acid developed in the reaction is completely soluble, so that the salt treatment method results in a marked increase of the soluble acid. The use of salts other than

[2] Soil acidity and a field method for its measurement. Ecology 1 : 160–173. 1920. Smithsonian Rept., 1920: 247-268. 1922.

KNO_3, such as $NaC_2H_3O_2$ or $CaCl_2$, will produce analogous effects, but the extent to which the reaction goes in one direction or the other, and correspondingly the amount of soluble acid developed, will vary with the salt selected. Titration will accordingly yield a value representing not the original acidity of the soil solution, but acid resulting from a reaction going to an equilibrium varying with a salt chosen at random. For any one salt, it is evident that the amount of acid developed will be more or less proportional to the colloid content of the soil under study. Since most of the lime added to soils in practice appears to be taken up by the colloids, these methods give, in some soils at least, rough indications of the lime-requirement; but this bears no apparent relation to the active acidity.

An explanation is thus afforded for the well known fact that the salt-treatment methods yield a value varying with the salt used; and it is concluded that while the results correspond roughly to colloid content, they are without significance as far as active acidity of the soil is concerned.

2. B. *Lime-requirement is determined by direct titration with lime-water.*—If an indicator which shows its color change at the neutral point is used, titration of the soil itself with lime water does yield a definite value for lime-requirement. This is not to be regarded as proportional to the active acidity, however. For, besides neutralizing active acid originally present in the soil solution, some of the lime is used in neutralizing inactive and practically insoluble acids, and some in decomposing iron and aluminum salts, while a further quantity is adsorbed by the soil colloids. There is reason to believe that a far greater amount is taken up in the last three ways than in the first. Actual comparison of the values for active acidity and lime-requirement obtained by several workers on the same soil samples has shown[8] that, with the units used (lime-requirement in parts per thousand, and active acidity in units of 10^{-7} grams per liter), the lime-requirement values ranged from 0.002 to 2.5 times the active acidity. Even though the majority of ratios lay between 0.02 and 0.10, the proportionality of the two quantities can not be regarded as particularly close.

It can only be inferred that lime-requirement determined by direct titration is not a measure of the active acidity of the soil.

3. A. *Active acidity is measured electrometrically.*—It has become the practice in recent years to measure active acidity by means of the hydrogen electrode, and to assume that this gives fundamentally dependable values. The fact that this method requires considerable

[8] Relations between the active acidity and lime-requirement of soils. Journ. Wash. Acad. Sci. 13: 97-162. 1923.

experience to operate, is usually overlooked, however. Not much experience is necessary when everything runs smoothly, but considerable may be required when all sorts of unexpected troubles arise and have to be avoided. For instance, the electrode is easily affected by impurities in the hydrogen or by mercury migrating over from the calomel comparison cell, and without being detected for a long time, may give results uniformly in error. Moreover the readings obtained may not be representative of the soil's original acidity, because the hydrogen may sweep out some carbon dioxide, or may reduce nitrates, and in either case yield an arbitrarily modified potential value.

It is concluded, then, that this method, while admittedly of great value, is not certain to yield the correct active soil acidity in every case.

3. B. *Active acidity is measured color-comparatively.*—The simpler color-comparative method of determining active acidity (or alkalinity) also possesses certain inherent disadvantages. The turbidity or color of the soil extract may mask the color changes, although the use of a cancelling-out device diminishes the difficulty from this source. The proteins and salts present in the soil solution may shift the equilibria of the dyes used to such an extent as to give erroneous readings. The addition of too much dye to the soil extract is one manipulative error which may occur, especially if the convenient spot plate is used. The majority of workers who have used the color-comparative and electrometric methods on the same soils, taking care to avoid errors of manipulation in both, have found that the two methods check one another well within the limits of variation of the material.

There is now on the market an apparatus for attaining a considerable degree of precision by the color-comparative method, even under field conditions. The soil extract is placed in a tiny celluloid cell, and mixed with a drop of the indicator found by preliminary tests to be visibly affected by it. The color produced is compared with that shown by the same indicator in a Barnett double wedge,[4] turbidity being cancelled out by the use of a cell containing untreated extract, placed behind the double wedge.

Utilization of data on active soil acidity and alkalinity.—Measurements of active acidity or alkalinity made as above described may be utilized to construct special soil-reaction maps. O. Arrhenius[5] has published such a map of an area in Sweden, showing by color patterns the patches occupied by soils of different acidity ranges. The writer[6]

[4] Colorimetric determination of hydrogen-ion concentration by means of a double wedge comparator. Proc. Soc. Exptl. Biol. Med. 18: 127–131. 1921.

[5] Bodenreaktion und Pflanzenleben. Special publication 20 pp. Gustav Fock, Leipzig, 1922.

[6] A soil acidity map of a Long Island wild garden. Ecology. 4: 395–501. 1923.

constructed one in which "acidity-contour" lines were used for the same purpose. However, a statement in the text of a soil survey report, concerning the usual reaction-range of each soil type covered, would be sufficient for most purposes.

Such information will make possible the selection of land most nearly suited to the active acidity or alkalinity needs of individual crops. As pointed out by Arrhenius in the paper cited and elsewhere,[7] every crop plant probably has its own optimum active acidity or alkalinity and can be grown most successfully in soils approaching this value. Although this optima for individual crops are not as yet very definitely known, they are sure to be determined sooner or later, and knowledge as to the reaction of given areas will then be of great importance.

Moreover, active acidity and alkalinity, besides favoring the growth of crop plants when present in certain amounts, produce other effects. It is well known that they are directly toxic when they reach sufficiently high concentrations and also that they influence the solubility of iron and aluminum, so that the toxicity of certain soils may be indirectly related to the reaction. They affect both beneficial and injurious soil organisms in a variety of ways, active acidity favoring, for instance, the development of nitrifying bacteria when its concentration approximates to 2 units (of 10^{-7} grams) per liter, and preventing that of the potato scab fungus when it exceeds 100 such units per liter. The importance of having information as to the active acidity or alkalinity of every agricultural soil is evident.

Summary.—The significance of active acidity as opposed to total acidity is pointed out. The methods which have been proposed for ascertaining the degree of acidity attained by a given soil are reviewed, and some of them are shown not to yield active acidity values at all. Both electrometric and color-comparative methods of determining active acidity have inherent defects, but when care is taken to avoid errors of manipulation, the two methods give accordant results. The second of these is the simpler, and a convenient apparatus for applying it in the field is now available.

Active acidity and alkalinity are important in connection with the growth of plants, both directly and indirectly. They may be directly toxic in high concentrations and indirectly toxic through affecting the solubility of iron and aluminum. They also exert a marked influence on the activities of various soil organisms, both beneficial and injurious. In the writer's opinion, no soil survey can be regarded as complete without including determinations of the reaction in terms of active acidity or alkalinity.

[7] Some contributions to the knowledge of the relation between soil reaction and the development of certain crop plants: An orienting investigation. (In Swedish) Kungl. Landtbr. Akad. Handl. Tidskr. 62: 417–428. 1923.

BOTANY.—*Notes on* Tacsonia.[1] ELLSWORTH P. KILLIP, National Museum.

The genus *Tacsonia* was established[2] by Jussieu in 1789 to accomodate certain species of *Passiflora* distinguished by a long flower tube and a reduced faucial corona. Up to 1873 it was generally recognized as valid, though there was much diversity of opinion as to which species should be placed in it. Masters, the principal authority on the Passifloraceae, retained it in his elaborate monograph,[3] although both in an earlier paper,[4] in which he discussed the genera of Passifloraceae in greater detail, and in the course of subsequent publication of new species under this generic name he evidenced much doubt as to the propriety of keeping it distinct from *Passiflora*. Triana and Planchon, in their monograph[5] of the Colombian Passifloraceae, made *Tacsonia* a subgenus of *Passiflora*, and Harms, who in recent years has been the principal student of the family, has so treated it.

Study of a great amount of Andean material now at hand, as well as of living plants in Colombia, has led me to agree with Triana and Planchon and Harms that the characters upon which *Tacsonia* has been recognized are neither sufficiently constant nor important enough to justify its retention as a genus distinct from *Passiflora*. The grounds upon which this opinion is based are stated in some detail in a manuscript soon to be published, dealing with the Andean Passifloraceae, and need not be repeated here. However, in order that the names of several species not yet removed from *Tacsonia* to *Passiflora* may be available, these transfers are now made.

Passiflora coactilis (Mast.) Killip, comb. nov.

Tacsonia coactilis Mast. Bot. Jahrb. Engler **8**: 216. 1887.

Passiflora ecuadorica Killip, nom. nov.

Tacsonia hederacea Mast. Journ. Linn. Soc. **20**: 29. 1883. Not *Passiflora hederacea* Cav. (1790).

Tacsonia cyanea Sodiro, Anal. Univ. Quito **18**: 410. 1903. Not *Passiflora cyanea* Mast. (1872).

Comparison of a specimen of the type collection of *Tacsonia hederacea* Mast., in the New York Botanical Garden, and the type of *Tacsonia cyanea* Sodiro, in the National Herbarium, proves that the two are conspecific. Both species names, unfortunately, would be invalid under *Passiflora*.

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Gen. Pl. 398. 1789.

[3] Mast. Fl. Bras. 13^1: 535–542. 1872.

[4] Trans. Linn. Soc. **27**: 625. 1871.

[5] Ann. Sci. Nat. V. Bot. **17**: 122–145. 1873.

Passiflora mandoni (Mast.) Killip, comb. nov.
Tacsonia mandoni Mast. in Mart. Fl. Bras. 13^1: 538. 1872.

Passiflora psilantha (Sodiro) Killip, comb. nov.
Tacsonia psilantha Sodiro, Anal. Univ. Quito **18**: 417. 1903.

ENTOMOLOGY.—*Notes on and descriptions of some sawflies from Japan (Hym.).* S. A. ROHWER, Bureau of Entomology.

The species treated in this paper were sent for determination in the summer of 1919, and shortly after their receipt a manuscript describing them was sent for publication in the Entomological Magazine. Unfortunately this magazine has been, at least temporarily, discontinued, and only recently was the manuscript returned. In the interval, certain Japanese students have written briefly concerning one of these species, and I am informed that manuscripts on the other two are in the course of publication. It is my understanding that these manuscripts deal with the habits and do not contain technical descriptions of the species.

Tomostethus (Eutotomostethus) **juncivorus,** sp. nov.

Allied to *luteiventris* (Klug), but the middle fovea is not deep and the claws have an inner tooth.

Female.—Length 6 mm. Robust. Clypeus gently convex with large setigerous puncture, the anterior margin truncate; supraclypeal area somewhat depressed, flat; antennal foveae large, deep; middle fovea represented by two impressed lines which diverge dorsally; ocellar basin large, octagonal, open above and below but the lateral walls well defined; a transversely oval depression in front of anterior ocellus; postocellular line distinctly shorter than the ocellocular; postocellar furrow well defined, angulate anteriorly; postocellar area well defined, convex; head shining with front subopaque; antenna short and stout, the third joint subequal in length with the fourth and fifth; thorax shining, the posterior part of the thorax with a few large punctures; stigma broad, rounded below; interradius strongly curved, joining radius at about the apical fourth of third cubital; nervulus distinctly beyond the middle of cell; nervellus well before middle of discoidellan cell; claws with an erect inner tooth; sheath straight above rounded at tip then sharply oblique then gradually widening to the base. Black; legs except bases of coxae and infuscate apical tarsal joints reddish-yellow; abdomen (including propodeum) rufo-ferrugineous, sheath black; wing hyaline, faintly dusky; venation black.

Male.—Length 5.5 mm. Structure as in female; hypopygidium broadly rounded. Black; apical joints of palpi, legs except bases of coxae and infus-

cate apical joints of tarsi yellowish with the femora reddish yellow; abdomen rufo-ferrugineous, propodeum, four apical tergites and two apical sternites black; wings as in female.

Type-locality.—Kurashiki, Okayama-keen, Japan. Described from two females (one type) and two males (one allotype) sent by Chukichi Harukawa who says the larva "feeds upon cultivated *Juncus* sp." Material labled May 1918.

Type.—Cat. No. 22390 U. S. National Museum.

In Insect World,[1] there is listed a *Tomostethus apicalis* Matsumura, but I can find no other record for such a species and have considered *apicalis* as a manuscript name.

Since the above description was prepared Mr. Harukawa has given me additional specimens, some of which belong to the second generation of the species. According to Mr. Harukawa, the second generation of females differs in color from the first. There is no apparent difference in structure in the male or female, but the females of the second generation differ from the first (or spring) generation in the following color characters: Pronotum, tegulae, mesonotum except a triangular spot on the prescutum, metanotum, and a spot on the posterior part of the mesepisternum rufo-ferrugineous.

Eriocampoides matsumotonis Harukawa

Eriocampoides matsumotonis Harukawa, Journ. Plant Protection, Tokyo, vol. 6, no. 1, Jan. 5, 1919, pp. 51–59, 1 plate; Harukawa, Ber. Ohara Instituts Forsch., Japan, Bd. 2, H. 1, 1921, p. 21.

This species was originally described as new from material received in 1919, but subsequently Mr. Harukawa has written two papers on it which contain sufficient descriptive matter and illustrations to fix the name and make it necessary to accredit the species to him. The following description of the material before me is published to give a more elaborate description of the adult and some comments on its relationship with exotic forms.

Of the Palaearctic species this species seems more closely allied to *lamacina* (Retzius) but it is smaller, the position of the interradius is different and there are also differences in the head.

Female.—Length, 4.5 mm. Clypeus smooth, the anterior margin rather deeply, broadly, subangulately emarginate, the lateral angles sharp; antennal foveae large, extending to base of clypeus; supraclypeal area convex, rectangular in outline; middle fovea elongate, open above, deep, well-defined; frontal foveae punctiform but in a gradually depressed area, situated a little below a line drawn tangent to top of middle fovea; ocellar basin indicated as a raised wedge-shaped area; postocellar furrow wanting; postocellar area convex; postocellar line longer than ocellocular line; vertical furrows distinct, deep; antenna about as long as head and thorax, slightly thicker in middle; clothed with stiff black hair, third joint but little shorter than the fourth and fifth, which are subequal in length; stigma large, straight below to an obliquely truncate apex; interradius straight, inclined at same angle as third intercubi-

[1] 23, no. 5: 886. 1919.

tus, joining radius distinctly before the middle of third cubital cell; third cubital subequal with the first and second; first, second and fourth abscissae of cubitus subequal; nervulus its length from basal; intercubitella well beyond recurrentella; anallen cell sessile at nervellus; sheath straight above to near apex when it narrows to a rather pointed apex, rounded below. Black, shining, with short black hair; four anterior tibiae and tarsi brownish-yellow; hind tibiae and tarsi brownish with a faint indication of a yellowish color; wings fulvigineous to apex of stigma then hyaline; venation black.

Male.—Length, 3.5 mm. Hypopygidium broadly rounded apically; interradius at about middle of cell; structure and color as in female. In the paratype male, the interradius joins the radius before the middle of the third cubital.

Redescribed from two females and two males sent by Chukichi Harukawa who says the larvae feed "upon the leaves of pear, peach and some other *Prunus* spp." Material labeled July, 1918.

In general appearance this species looks more like *E. amygdalina* Rohwer than it does like *E. limacina*, but it is to be distinguished from *amygdalina* by the darker legs and wings and different shaped middle fovea.

Hoplocampa (Hoplocampa) **pyricola,** new species.

This species is very closely allied to the European *H. minuta* and will fall there in Enslin's key to the species. It differs from European specimens determined by F. W. Konow as follows: the transverse depression above the median tubercle is straight (not curved); the emargination of the clypeus is arcuate (not slightly angulate); the sheath is sharply pointed at the apex (not narrowly rounded); the contraction of the lanceolate cell is equal (not longer than) with the nervulus; the stigma is more distinctly truncate; the cubitellan cell is longer (not shorter) than the discoidellan cell. Practically all European literature records *minuta* as living within the fruits of *Prunus,* while this new species is said to live within the fruits of *Pyrus.*

Female.—Length, 3.5 mm. Clypeus convex, the anterior margin broadly, shallowly, arcuately emarginate; supraclypeal area polished, strongly convex, rectangular in outline; depression across the top straight; median fovea represented by broad, shallow, poorly defined depression; antennal furrow complete; postocellar furrow complete, straight; postocellar area slightly convex; antenna slender, third joint slightly shorter than fourth. Black; apices of antennae piceous; tibiae except infuscated apices, and tarsi sordid whitish; wings subhyaline; venation pale brown.

Male.—Length, 3.25 mm. The male agrees very closely with the female except the median fovea is slightly better defined and the flagellum is entirely ferrugineous; the apical portions of the femora and the anterior pair beneath are rufo-piceous.

Type-locality.—Yokohama, Japan. Described from six (one type) females and four (one allotype) males reared April 27, 1917, from pear fruits and forwarded by S. I. Kauwana.

Type.—Cat. No. 22391, U. S. N. M.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

892D MEETING

The 892d meeting, being the 53d annual meeting, was held in the Cosmos Club Auditorium on Saturday, December 1, 1923. It was called to order by PRESIDENT WHITE with 43 persons in attendance.

The joint report of the Secretaries for the year 1923, read by J. P. AULT, Recording Secretary, may be summarized as follows: Nineteen meetings were held during the year. Thirty papers and six informal communications were presented, 156 members taking part in the discussion.

The General Committee held 14 meetings during the year. The sum of $1200 was appropriated to cover the expenses of the Society during the year.

The following officers were elected for the year 1924:

President, D. L. HAZARD.

Vice-Presidents, W. BOWIE, H. H. KIMBALL.

Treasurer, P. R. HEYL.

Corresponding Secretary, L. H. ADAMS.

Member at Large, General Committee, S. J. MAUCHLY, F. E. WRIGHT.

While the tellers were counting the ballots, President White gave opportunity for an informal communication. Mr. Hawkesworth presented an informal communication *Change of density of the earth's crust with increased distance below the earth's surface*. The communication was discussed by Messrs. HEYL, LAMBERT, and TUCKERMAN.

Following the business session, H. L. CURTIS addressed the Society on a *Camera for Photographing Projectiles in Flight*. The paper was illustrated with lantern slides, and one of the cameras used in the experiments was exhibited. The following members took part in the discussion: Messrs. PAWLING, MAUCHLY, HAWKESWORTH, CRITTENDEN, LAMBERT, HEYL, HUMPHREYS, HAZARD, and WADLEIGH.

It is possible with an ordinary camera to obtain a picture of a projectile in flight provided the time of exposure is extremely short and provided also that the operator is sufficiently fortunate to make the exposure at the right instant. With the moving picture camera one will usually obtain a single picture of a projectile which will be blurred and indistinct. For photographing small projectiles, the method of illumination by means of a spark has given very satisfactory pictures. One or two methods have been devised for taking pictures by daylight. The camera which is here described is of the latter type, and employs some principles which have not heretofore been used. In this, the film is caused to move with the same velocity as the image of the projectile. This produces a picture which is free from blur and distortion. By mounting a number of lenses at right angles to the motion of the film, and by properly arranging the openings in the focal plane shutter, it is possible to obtain as many pictures of the projectile as there are lenses. Also, by determining the speed of the film by means of flashes of light from a tuning fork, and by knowing the distance from the projectile to the camera, it is possible to compute the velocity of the projectile.

Eleven lantern slides were shown which were made from pictures taken with this camera. All of these showed that projectile in flight in different positions, some near the muzzle of the gun, others in free flight, and still others as the projectile was entering an armor plate. (*Author's abstract.*)

893D MEETING

The 893d meeting was held in the Cosmos Club Auditorium on Saturday, December 15, 1923. The meeting was called to order by President Hazard with 40 persons in attendance.

The Secretary called the Society's attention to the meetings of the Geological Society of America to be held during the last week in December in the Auditorium of the Department of the Interior.

Program: I. F. HAND: *Investigation of the dust content of the atmosphere.* The paper was illustrated with lantern slides and a dust collector was exhibited.

Daily 8 a.m. determinations of the dust content of the atmosphere have been made by the Weather Bureau since December 7, 1922, at the American University, D. C., as part of an international study carried on by twelve countries belonging to the International Union of Geodesy and Geophysics. The purpose of this investigation is threefold: (1) To correlate the number of particles with visibility, (2) to study the effect of atmospheric dust upon the transmission of the atmosphere for solar radiation, and (3) to study the pollution of the atmosphere in cities. Incidentally, it was hoped that dust of cosmical origin might be identified.

Only particles which may be seen with the aid of a microscope magnifying 1000 diameters are counted. The method thus differs from Aitken's in which water drops are counted under the assumption that each drop contains a dust particle as a nucleus.

Charts were shown giving the relation between the number of particles and visibility; the vertical distribution of dust particles up to 10,000 feet as obtained during numerous airplane flights; and the seasonal variation in the number of particles.

The size of the particles diminishes with altitude, so that on an average the mass of the particles per unit volume at sea-level is 500 times the mass at 10,000 feet.

Miscellaneous observations made during airplane flights were described, including the following: (1) Study of the height of the upper limit of haze, which at times was very sharply defined. (2) Color effects of haze, clouds, sky, water, and ground surfaces with respect to distance, azimuth of sun, heights, etc. (3) Study of the air movement in and around cumulus and alto-cumulus clouds. (4) The observation of a super-cooled alto-cumulus cloud which, although the water content was in liquid form, was below freezing, as ice formed on the wings and struts of the plane and at 14,000 feet the Brocken Specter and Fog Bow were observed. (5) The dissipation of a cumulus cloud by repeatedly passing through it.

A summary of the year's work along this line will be published in an early number of the Monthly Weather Review. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. LITTLEHALES, BOWIE, KIMBALL, HUMPHREYS, GISH, and BAUER.

H. F. JOHNSTON: *Atmospheric-electric observations during the recent total solar eclipse.* (Illustrated with lantern slides.)

The Department of Terrestrial Magnetism made observations of potential gradient, positive conductivity, and negative conductivity at Point Loma near San Diego, California, September 10, 1923, as well as control observations for the four preceding and following days. Improved bifilar electrometers, which gave dependable determinations of potential, were used. Potential gradient was observed both by eye-readings and by continuous photographic registration. Conductivity was observed simultaneously with two Gerdien conductivity apparatuses. Meteorological conditions were very steady for the day of the eclipse; there was a total range of 2.5° Centigrade in temperature, 9 per cent in relative humidity, and 0.02 inch in barometric pressure. During the 20 minutes following totality, the temperature decreased 0.8° Centigrade, and the relative humidity increased 3 per cent. The sky was completely overcast with fog which extended above 17,000 feet. Observational irregularities due to leak on account of increased humidity or alteration of instrumental constants caused by changes in temperature were smaller than the errors of observation. It was found that the potential gradient for about half an hour immediately following totality was 15 per cent subnormal. The electrical conductivity of the air and the vertical electric air current increased 10 per cent above normal during the 10-minute period following totality. These results are in close agreement with those observed at Lakin, Kansas, in 1918 and at Sobral, Brazil, in 1919. There was a greater increase in the negative conductivity than in the positive conductivity of the order of 15 per cent. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. MAUCHLY, BAUER, HAZARD, and HUMPHREYS.

J. P. AULT: *Effect of the solar eclipse of 1923 on the earth's magnetic field.* (Illustrated with lantern slides.)

This paper presents a preliminary report on special magnetic observations made by the Department of Terrestrial Magnetism at Point Loma and Mt. Wilson, California, and at Guatemala City, Guatemala, during the solar eclipse of September 10, 1923. At Point Loma, magnetic declination, horizontal intensity, and inclination observations were made while at the other two stations only declination observations were made. Methods and instruments similar to those used during previous eclipses were employed, and the eclipse effects on the Earth's magnetic field were similar to those previously observed. The usual diurnal variation in the Earth's magnetism was interrupted, the change amounting to from 1½ to 3 minutes in declination, 60 gammas in horizontal intensity, and 1½ minutes of inclination. A complete analysis and discussion must await the receipt of data from other observatories located near the belt of totality. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. HAZARD, BAUER, HUMPHREYS, LITTLEHALES, and GISH.

894TH MEETING

The 894th meeting was held in the Cosmos Club Auditorium on Saturday, January 12, 1924. The meeting was called to order by President Hazard with 62 persons present.

The address of the evening was given by the retiring President W. P WHITE, *Ethics of research.* The address was discussed by Messrs. HEYL, HUMPHREYS, and LITTLEHALES.

895TH MEETING

The 895th meeting was a joint meeting with the Washington Academy of Sciences and the Geological Society of Washington, and was held in the Auditorium of the Interior Building.

The meeting was called to order at 8 p.m. by President A. L. DAY of the Washington Academy of Sciences.

Two addresses were delivered by Dr. T. A. JAGGAR, *The Hawaiian volcanoes* and *The Tokio earthquake*. These addresses were illustrated with lantern slides and motion pictures.

896TH MEETING

The 896th meeting was held in the Cosmos Club Auditorium on Saturday, February 9, 1924. The meeting was called to order at 8:20 p.m. by President Hazard with 56 persons present.

Program: W. BOWIE: *The use of geodetic measurements in detecting horizontal and vertical earth movements.* (Illustrated with lantern slides.)

As a part of the comprehensive plan to study earth movements in regions of seismic activity, outlined by the Committee on Seismology of the Carnegie Institution, of which Dr. A. L. DAY is chairman, the Coast and Geodetic Survey sent a triangulation party to California in 1922 under the direction of C. L. GARNER to reoccupy old triangulation stations, with a view to detecting whether or not there had been any changes in the geographic positions of the several stations since their establishment 35 or more years ago.

After the earthquake of 1906 the Coast and Geodetic Survey sent parties to the field to remeasure the horizontal angles at a number of stations in the vicinity of San Francisco Bay in order to determine whether or not movements had taken place in horizontal directions and the extent of such movements. Reoccupation of the stations was made during the years 1906 and 1907. For that work the line joining stations Mocho and Diablo, somewhat to the eastward of the San Andreas fault, was used as a base, and its length and the positions of its ends were assumed not to have been affected by the 1906 earthquake.

After a careful analysis of the situation, the conclusion was reached by the Committee on Seismology of the Carnegie Institution and the officials of the Coast and Geodetic Survey that it would be better to start the triangulation for the present studies from the stations Round Top and Mt. Lola, peaks on the Sierra Nevadas to the eastward of San Francisco, rather than to depend on stations near the coast.

During the season of 1922, the reoccupation of stations had progressed from the Sierra Nevadas westward to the coast and thence southward just beyond Mt. Hamilton. During the season of 1923 work was resumed where it had been discontinued in 1922 and old stations were reoccupied down to the Santa Barbara channel. Owing to the presence of persistent fogs in Santa Barbara channel, which prevented observations between mainland and island stations, the party was moved to the southern end of the coast triangulation to the eastward of San Diego. Beginning with station Cuyamaca, not far from the Mexican boundary, old triangulation stations were reoccupied along the coast to the Santa Barbara channel. Unfortunately, lack of funds prevented a connection being made with the observations which had been carried to the southward of San Francisco Bay. The connection will be made during the season of 1924.

Preliminary values for the new positions of the triangulation stations, computed from the stations Mt. Lola and Round Top as a base, are now available for comparison with the positions furnished by the original observations. The results of the comparison indicate rather clearly that there has been no movement for 100 miles or more to the westward of Mt. Lola and Round Top. There have been decided changes in position for most of the coast stations. Some of the change in position is necessarily due to the unavoidable accidental errors of triangulation, while at many of the stations the differences in position indicate very clearly that actual earth movements have taken place. It is expected that a publication of the Coast and Geodetic Survey will appear in the not distant future which will show, in tables and graphically, the difference in position of each of the stations involved with an analysis of the portion of the difference which may be due to errors of triangulation and to earth movements.

It is expected that triangulation will be done over all parts of California which show evidence of recent seismic activity. It is also planned to have lines of precise leveling extended over those areas. From time to time in the future, the triangulation and leveling can be reproduced with a view to learning what horizontal and vertical movements have taken place during the interval between the observing periods. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. LAMBERT, WRIGHT, HUMPHREYS, and RUDE.

S. J. M. ALLEN: *Passage of X-rays through matter, and the atomic structure of commercial materials.* (Illustrated with lantern slides.)

The general radiation from a tungsten Coolidge x-ray tube reflected from a crystal was examined from $\lambda = 0.10$ to $\lambda = 0.51$ A for the total mass absorption, in the metals C, Mg, Al, S, Fe, Ni, Zn, Ag, Sn, W, Pt, Au, Pb, and Bi. The α and β radiation from a Mo tube was also examined for $\lambda = 0.63$ A and 0.71 A. Systematic calculations showed that, if properly chosen values of the scattering were taken, the results could be expressed by formulas of the form $\mu/\rho = C\lambda^n N^p + \sigma/\rho$ over the range of λ and for N up to 0.74. The heavy elements do not agree with the above formula, the "jump" in μ/ρ from L to K absorption decreasing from 5.60 for W to 3.30 for Bi, whilst for Ag it was 7.85. In the atomic form, $C_K = 2.19 \times 10^{26}$, and $p = 4$. Very good agreement was found with the results of Richtmyer and Duane, wherever they paralleled.

The second part of the paper was a report on work done by Walter Soller at the University of Cincinnati. A Bragg x-ray spectrometer was equipped with two specially designed collimators, in place of the ordinary slits, each consisting of a large number of parallel strips of metal arranged in a vertical plane, one being placed between the specimen and the target, the other between the specimen and the ionization chamber. The target was placed so that its plane was perpendicular to the axis of the collimator. The first collimator allows only an essentially parallel beam of large cross-section to irradiate the specimen, the second analyses only those pencils of rays which are almost parallel to a given direction. Experiments showed that the α radiation from a Mo water-cooled tube could be resolved into the α_1 and α_2 components when reflected from a specimen of commercial iron strip. When the strip was heated through 450°C., the observed shift of the peaks corresponded to the shift to be expected from calculation of the thermal expansion of the crystals. When the strip was stretched mechanically, there was observed a decided shift of the peaks. With this spectrometer it is not necessary in any way to prepare the specimen by etching or powdering. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. FOOTE, MOHLER and RAWDON.

897TH MEETING

The 897th meeting was held in the Cosmos Club Auditorium on Saturday, February 23, 1924. The meeting was called to order by President Hazard with 35 persons in attendance.

Program: C. V. HODGSON: *Structural improvements in modern micrometer theodolites.* (Illustrated with lantern slides).

The paper as presented did not take up the details of micrometer construction or of the general structural arrangements of theodolites, but discussed the progress in the art of designing and making theodolites and compared some of the older types with the modern theodolite in respect to accuracy and convenience.

Slides were shown to illustrate the general appearances of the principal types of precision theodolites used in this country during the past century. Progress in design has been toward compactness, decreased weight and increased convenience, rather than toward revolutionary changes in principle. In workmanship and materials little progress has been made in the past two decades, though a development in the metallurgical processes for making invar, duraluminum and other of the newer alloys may render them more available in the future.

Of the three or four principal structural features of theodolites, the accuracy of the observations depends chiefly upon two—the correctness of the graduation of the circle, and the design and construction of the micrometers. Slides were used to show the magnitude of the errors of graduation of some of the modern theodolite circles, and the sources of the larger errors.

The methods used in testing the graduations were briefly touched upon. Where the error in position of the graduation marks is tested by special apparatus using micrometric measurements, it was estimated that the method of standardization would not determine the errors much closer than 0.3″ on a circle 12 inches in diameter.

The excellence of a theodolite may also be gauged by plotting to scale the differences between the readings of two micrometers, taken at intervals around the circle. A study of the variations of these plotted points from the mean curve drawn through them enables a close estimation to be made of both the errors of graduation and excellence of the micrometers.

There is not in the United States any organization equipped to test adequately the errors of graduation of a circle, and make certification as to its errors. There is need for some agency to assume such a function, for such standardizations would render harmless the extravagant claims of accuracy made by some manufacturers, and would encourage conscientious makers of high-grade instruments to greater precision. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. PAWLING, W. BOWIE, and HAZARD.

W. R. GREGG: *The relations between free air temperatures and wind directions.* (Illustrated with lantern slides.)

All available data from kite flights made during the period 1915 to 1922 inclusive have been considered. The investigation has been pursued along the following lines: (1) The temperatures at different heights have been classified according to surface wind direction; (2) the temperatures at 3 kilometers have been classified according to wind direction at that level; and (3)

changes in temperatures at 3 kilometers, as observed during series of successive kite flights extending over periods of several hours, have been examined individually in connection with the wind direction or with changes in the wind direction. It is found (a) that in a large majority of cases the relation between temperatures and wind directions is direct and appreciable, south component winds being considerably warmer than north component winds at all levels in the troposphere; (b) that the relation is more pronounced at 1 and 2 kilometers than it is at greater heights or at the surface; and (c) that exceptions to (a) are due either to a temporary reversal in the latitudinal distribution of temperature or to the fact that the wind direction in some instances does not represent the true source of the air, the latter having followed a curved path round a High or Low. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. HAZARD, AULT, and HUMPHREYS.

898TH MEETING

The 898th meeting was held in the Auditorium of the Cosmos Club on Saturday March 8, 1924. The meeting was called to order at 8:15 p.m. by President Hazard with 35 persons present.

Program: C. LEROY MEISINGER: *Barometric reductions in the plateau region of western United States.* (Illustrated by lantern slides.)

In seeking a suitable level to which to reduce barometric pressures in the Plateau Region of Western United States, it is desirable to choose one that is fairly representative of weather conditions at the surface of the Plateau. This choice has the advantage of greater accuracy than is possible in sea-level reductions since the vertical distances between barometers and the reduction level are much shorter, hence exercise less influence upon the reduced pressure.

The levels 1 and 2 kilometers above sea-level have been used in the eastern United States for the purpose of barometric reduction, and it is found that very reliable results can be obtained in reducing to the same two levels in the Plateau Region. The short air columns permit the use of current surface temperatures as the temperature argument in the reduction equation to produce a smooth homogeneous system of isobars.

A new method of barometric reductions to the levels 3 and 4 kilometers above sea-level has been devised for the eastern United States. This method depends upon the ratios of pressure at the surface, 1, and 2 kilometers above sea-level. Both practical and theoretical considerations show that the linear relation,

$$p_x = p_s\,(bp_2/p_1 + a)$$

in which p_x, p_s, p_1 and p_2 are the barometric pressures at some high level, say, three of four kilometers above sea-level, the surface, 1 and 2 kilometers above sea-level, respectively, is useful in computing these pressures. A method for the computation of the linear constants for use at Plateau Stations was presented together with maps for the several levels. These charts afford an opportunity to study the current distribution of barometric pressure to high levels in the atmosphere with as much promptness and ease as is possible with the present sea-level map. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. PAWLING, TUCKERMAN, HAWKESWORTH, and HUMPHREYS.

E. W. WASHBURN: *A calorimeter for measuring heat effects at high temperatures.* (Illustrated with lantern slides.)

Discussion. The paper was discussed by Messrs. WHITE, L. H. ADAMS, and HAWKESWORTH.

W. P. WHITE presented an informal communication, *Some results obtained during tests of a crude calorimeter*. This communication was discussed by Messrs. Humphreys and Tuckerman.

J. P. AULT, *Recording Secretary*.

THE BIOLOGICAL SOCIETY

659TH MEETING

The 659th meeting of the Biological Society was held in the lecture hall of the Cosmos Club January 5, 1924 at 8 p.m., with Vice-President OBERHOLSER in the chair and 60 persons present.

New members elected: C. S. BRIMLEY, FRANK C. BALDWIN.

The mêmbership of the following committees was announced: *Committee on Communications:* E. A. GOLDMAN, chairman, S. A. ROHWER, H. C. OBERHOLSER, C. E. CHAMBLISS, J. S. GUTSELL, W. R. MAXON; *Committee on Publications:* C. W. RICHMOND, chairman, J. H. RILEY, T. E. SNYDER, F C. LINCOLN, G. S. MILLER, JR.; *Committee on Zoological Nomenclature:* G. S. MILLER, JR., chairman, P. BARTSCH, S. A. ROHWER, E. A. CHAPIN, H. C. OBERHOLSER.

President J. W. GIDLEY was elected a vice president of the Academy of Sciences as representative of the Biological Society of Washington.

Under *Short Notes*, S. F. BLAKE, announced the observation of a Bluegray Gnatcatcher in Washington on January 1, 1924.

W. E. SAFFORD: *Economic plants as indicators of the origin and migrations of primitive races* (illustrated). Ethnologists and anthropologists often disagree as to the importance of the arts and industries of a primitive tribe or the physical characteristics of a people as factors in determining its origin. In contrast with the similarity between arts which may have originated separately and with resemblances which may be more or less fortuitous or imaginary, the botanist has something definite to offer when he contributes his aid in solving questions of origin and relationship of primitive races.

When the earliest explorers of the Pacific Ocean encountered the Polynesians they found that they were cultivating a number of plants for food and for economic purposes, nearly every one of which had been known for centuries in southern Asia and the adjacent islands. The most important were coconut, breadfruit, bananas, plantains, common yam (*Dioscorea alata*), turmeric, Polynesian arrowroot (*Tacca pinnatifida*), sugar cane, species of screwpine (*Pandanus*), also a number of trees such as *Hibiscus tiliaceus* and the candlenut (*Aleurites moluccana*). The plant from which the Hawaiians derive their *poi* and the Samoans their *palusami* proved to be identical with *Colocasia esculenta*, the qulqás of the Arabs and the arum of ancient Egypt. Nearly all these plants could be traced to the Malay Archipelago and many of them even retained their ancient Malayan names. The dialects of the Polynesians themselves could also be traced back to the same source, demonstrating the absurdity of the theories, so often repeated in recent times, that the Polynesians are of Caucasian origin.

Turning to America there is a striking contrast. Every cultivated plant encountered in the New World by Columbus and his companions and by their successors on the mainland both north and south of the Equator was unknown before the discovery. No foodplant or other cultivated staple from Europe, Asia, or Africa had reached this continent in Precolumbian times. Even the various species of cotton used for textile purposes in the Antilles and on

the mainland were so distinct that they would not cross with Old World species. All the plants cultivated by the various tribes had been developed from wild American plants,—maize from a wild grass, beans from vines in thickets, sweet potatoes from wild morning-glories, squashes and pumpkins from wild gourds, white potatoes from wild Solanums growing in the Andine region of South America, and tobacco from wild species of *Nicotiana.*

Very little is known regarding the connection between the tribes of North and South America. By linguistic methods, however, it is possible to trace connections between the Aztecs of Mexico and various tribes in North America as far as the Shoshones to the northward, and a relationship to other tribes of Salvador and Costa Rica to the southward. Making use of the common foodplants, tobacco, peanuts, cotton, *Bixa orellana* and *Genipa americana,* used for painting the body, it is possible to trace the origin of the Caribs and Arawaks encountered by Columbus in the West Indies to the very heart of South America. Similarly the black Caribs of Guatemala, descended from negro slaves and their Carib masters of the West Indies, can be traced by means of their manioc, or cassava, and other food plants to the Caribs of the Antilles; and this relationship is corroborated by the language which they still speak, that of the women and the men differing from each other, as it did in those islands.

There is a difference between the intrusion of a plant with its complex method of cultivation and preparation, and the introduction of a plant by means of seeds or roots sent from one country to another. An example of this is the manioc just referred to. When the black Caribs were transported from their island home to the east coast of Central America, they took with them their method of preparing the cassava, expressing the poisonous juice by means of a long hollow woven snake-like cylinder. When manioc roots were sent to Africa, not carried there by immigrants, no knowledge of methods of manufacture of cassava accompanied them; and the natives at present prepare it by allowing the root to ferment and thus destroy its poisonous qualities. They do not have the peculiar snake-like tubes, which were first invented by tribes in Brazil, carried into the Antilles and thence to the main-land of Central America. This is a striking example of the difference between the introduction of a plant and of the bringing into a new country of a complex by migrant tribes or groups of people. Maize found its way to the Island of Guam together with the *metatl* and *mano*, and was prepared in the form of tortillas; thus establishes the fact that Mexicans migrated from Mexico to Guam, as we know to be the fact, when the Spaniards transported Mexican troops to reduce the native Chamorros. The introduction of corn, beans, and squashes into North America from the south was a very different matter. Evidently the seeds were carried there by people not familiar with Mexican or Central American methods of preparing these articles for food. Thus it may be seen that cultivated plants are important as indices of the origin and migrations of primitive peoples. (*Author's abstract.*)

VERNON BAILEY: *Some habits of the grasshopper mouse, an insect-eating rodent* (illustrated). The speaker exhibited a specimen of *Onychomys leucogaster melanophrys*, a grasshopper mouse from northern Arizona, and described its habits, both in the wild state and in captivity. The animal is very active, almost weasel-like in some of its actions.

660TH MEETING

The 660th meeting was held at the Cosmos Club January 19, 1924 at 8 p.m., with President GIDLEY in the chair and 41 persons present.

Short Notes. B. A. BEAN announced that the Bibliography of Fishes which has been in course of publication by Prof. BASHFORD DEAN for many years has now been completed.

PAUL BARTSCH reported that he has recently observed gray squirrels scratching and rolling in decayed wood from a porch which is being repaired, in much the same way that cats do in catnip. E. A. GOLDMAN suggested that this might be to keep their fur in condition, but Dr. BARTSCH doubted that this was the case.

PAUL BARTSCH: *Additional facts concerning the Cerion breeding experiments* (illustrated). The Cerions form a family of terrestrial mollusks distributed from the Florida Keys and the Bahamas south over the Greater Antilles from Cuba east to the Virgin Isles excepting Jamaica. A colony is also found on the island of Curaçao, and one species has been reported from the mainland of South America at Berbice, British Guiana.

The fact that Cerions always occur in great abundance wherever they are found and embrace a large number of species occupying usually very circumscribed areas renders these forms particularly interesting subjects for biologic inquiry.

Efforts so far have been directed along two lines: one, to determine the effects of environment, the other to determine the effects of hybridization. In the first series of experiments a large number of individuals of two species of Bahaman Cerions was planted on alternate keys between Miami and the Tortugas, a distance of over 250 miles. These keys present a great range of variation in temperature, moisture, food, and other environmental factors. The various generations resulting from these colonies, which consisted of 500 individuals each, have been kept apart and carefully studied. All the measurable characters presented by the F_1 and F_2 generations of these two species have failed to show any response to the changed environment. At the Tortugas, additional species have been introduced from Porto Rico and Curaçao, the offspring of which likewise show no change from the parent stock in the Florida grown generations.

In the second experiment the Floridan *Cerion incanum* was crossed with *Cerion viaregis* from Andros Island, Bahamas. The offspring show an enormous diversity of modification in which one can recognize many of the types of modifications existing among the hundreds of species which occupy the Bahama Islands today. It is not far amiss to say that all the main factors of modification are represented here except that of spiral striations. It will be interesting to note what results fixation through isolation and inbreeding will produce.

It seems likely that the large number of species of Cerion found in the Bahamas today may be due to a cross probably made possible by the abstraction of water from the seas during the glacial period, resulting in the wide spreading of an exceedingly variable hybrid which later, through the return of the water to the seas by the melting of the ice cap, resulted in the production of an endless number of isolated colonies where, by inbreeding, fixation has taken place, giving us the hundreds of species which we now find in the region. (*Author's abstract.*)

C. D. MARSH: *Relation of poisonous plants to milk-sickness in man and animals.* The first publication in regard to the disease which came to be known as "milk-sickness" was in 1810, although the disease had probably been known for many years before that time. The disease has been at times very prevalent in the states from the Carolinas west to Missouri. While the disease was first known amongst men, later it was found to affect practically

all domestic animals. It came to be known as "milk-sickness" because it was thought that it was conveyed from cattle to human beings by means of milk and butter. It was also known as "trembles" because of one of the prominent symptoms amongst cattle. It was a mysterious disease and the cause was not definitely known until very recent times. Some thought it to be of mineral origin. Some thought it due to an emanation from the soil, and many thought it was caused by some plant which was consumed by grazing animals. In the first decade of this century, it was quite generally thought to be of bacterial origin. Experiments made by the U. S. Department of Agriculture and confirmed by many other investigators have shown quite conclusively that the disease in animals is caused by eating white snakeroot (*Eupatorium urticaefolium*).

A similar disease, sometimes also called milk-sickness, perhaps more commonly alkali disease, has been common in the Pecos Valley in New Mexico. This also was thought to be caused by bacteria, but now it has been shown by the work of the Department of Agriculture that this disease, which produces symptoms practically identical with those of the Eastern milk-sickness, is caused by a plant commonly known as rayless golden rod or Jimmy weed (*Isocoma wrightii*). (*Author's abstract.*)

661ST MEETING

The 661st meeting was held in the Lecture Hall of the Cosmos Club February 2, 1924, at 8 p.m., with President GIDLEY in the chair and 90 persons present. WILBER BROTHERTON, JR. was elected to membership.

Under *Short Notes*, VERNON BAILEY described the behavior of chipmunks from northern Michigan, kept under approximately natural conditions in his backyard. They have stored a considerable amount of food but have not hibernated. It is not known whether the chipmunks in the north truly hibernate or whether they keep awake during the greater part of the winter.

Dr. C. W. STILES stated that the proposed suspension of the rules in the case of the typification of *Musca* has not yet been settled. Voting so far favors the retention of *M. domestica* as type. It is hoped that entomologists will refrain from other usage until the matter is finally settled.

A. WETMORE: *Visit of a naturalist to Wake Island* (illustrated).—Wake Island, discovered in 1796, is located in the western Pacific, 19° north of the Equator, and approximately 2,000 miles west of Honolulu. It lies distant 1,330 miles from Guam, with Taongi Atoll, an outlier of the Marshall group, and Marcus Island as the nearest land. The island was visited for a few hours by naturalists on the Wilkes Expedition on December 20, 1841, and in 1892 a Japanese vessel secured specimens of a land rail that later came into possession of the Tring Museum, and were described by Rothschild in 1903 as *Hypotaenidia wakensis*. The U. S. S. "Beaver" secured a few land crabs there in June, 1922, which were given to the Bishop Museum. These, so far as known, constitute the only occasions on which natural history collections were made on the island until the summer of 1923, when an expedition organized by the Biological Survey, U. S. Department of Agriculture, and the Bishop Museum of Honolulu, in cooperation with the Navy Department, came to Wake Island on the U. S. S. "Tanager" and remained there for a period of nine days. The scientific party, under direction of the speaker, made complete collections of the land flora and fauna, and secured as complete a representation of the marine life of the reefs as practicable in the time available. At the same time, the three islands forming the atoll were accurately mapped, and their proper location determined by numerous observations. The speaker gave a résumé

of the more striking features in various branches of natural history, with narration of various episodes in connection with life in camp, and the work of the party. Complete accounts of the collections made will be published in the bulletin series of the Bishop Museum in Honolulu. (*Author's abstract.*)

The paper was discussed by E. A. GOLDMAN and R. W. SHUFELDT. Dr. Shufeldt described a meeting with Capt. WILKES in 1863, and a later one in Washington just before Wilkes' death.

MAURICE K. BRADY: *Salamanders of the District of Columbia.* The speaker described the salamanders of the District and illustrated them with lantern slides and a few living specimens. One species new to the District, *Pseudotriton montanus montanus*, has been found since the publication of Hay's list. No specimens have hitherto been known from the area between North Carolina and the type locality near Carlisle, Pa. The suggestion was made that several species included on hypothetical grounds by Hay should be eliminated.

662D MEETING

The 662d meeting was held at the Cosmos Club on February 16, 1924, at 8 p.m., with Vice-President OBERHOLSER in the chair and 67 persons present.

Under *Short Notes.* Dr. PAUL JOHNSON read an extract from a medical journal, indicating a considerable degree of correlation between certain physical measurements and the susceptibility of humans to certain diseases.

M. K. BRADY stated that he and E. J. COURT had found half a dozen adult specimens with larvae or *Pseudotriton montanus montanus* at Mt. Vernon, Virginia, since his recent report of the species from near Little Hunting Creek. The species was in association with *P. ruber*.

L. O. HOWARD: *Importing foreign parasites of introduced injurious insects.* (illustrated). The speaker described and illustrated by lantern slides a considerable number of our important injurious insects, and gave an account of the attempts made to combat their ravages by the introduction of parasites. The usual method by which these were discovered was the observation in their Old World home of the insects themselves and of the parasites which naturally preyed upon them there. In this way it has been possible to control or almost exterminate a number of important introduced pests.

VERNON BAILEY: *Hoarding habits of mammals in relation to disposition and social instincts* (illustrated). The speaker described the life and feeding habits of a number of American mammals, with particular reference to their habit of storing food. The varied dispositions of the species, particularly of the rodent tribe, were described and the strong resemblance to many human qualities was mentioned. The paper was illustrated by colored slides.

663D MEETING

The 663d meeting was held at the Cosmos Club March 1, 1924 at 8.10 p.m., with Vice-President OBERHOLSER in the chair and 111 persons present.

Under *Short Notes*, A. S. HITCHCOCK spoke of progress in the construction of the laboratory to be maintained in the Canal Zone by the Institute for Research in Tropical America.

H. M. ALBRIGHT, Superintendent, Yellowstone National Park: *Progress in wild life protection in Yellowstone National Park* (illustrated). The speaker showed a large number of beautifully colored lantern slides illustrating the scenery and wild life of the Park. He reported that the elk and antelope have wintered very well, and that both are rapidly increasing in numbers. In conclusion, he showed a remarkable moving picture of the Rocky Mountain goat in its native haunts.

O. F. Cook: *The domestication of plants in Peru* (illustrated). The origin of civilization may be traced through agriculture, by locating the centers of plant domestication. In the American continents the chief domestication center undoubtedly was located in the Peruvian region, as shown by the large series of plants cultivated by the ancient Peruvians, greatly exceeding the domesticated series of any other region. The Peruvian domestication covered the whole range of agricultural conditions, from the tropical valleys of the eastern Andes to the highest limits of cultivation, above 14,000 feet. Most of the chief economic groups, root-crops, seed-crops, garden vegetables, fruits, ornamentals, and medicinal plants are represented by several species growing at different altitudes.

Though many of the low-elevation species were also cultivated widely in tropical America, many of the high-altitude species are still restricted to the Peruvian region. The presence of closely related wild plants affords further evidence of the place of domestication of many of the species, and the very specialized development of agriculture in Peru is another indication of great antiquity. From the nature of the stonework in the terraces, some of them must go back to a remote prehistoric age. The construction of terraces and irrigation works, including the artificial placement of the soil over many square miles of the terraced valleys, required an enormous application of labor and a notable development of engineering and organization ability, that probably required a very long period of time. (*Author's abstract.*)

S. F. Blake, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The Petrologists Club met at the home of L. M. Prindle, April 18. The following papers were presented:

F. L. Hess, *Rutile deposits of Virginia.*

D. F. Hewett, *Mass changes in replacement.*

E. T. Wherry, *Volcanic rocks of South Mountain, Pa.*

The paper by Mr. Hess was preparatory to the proposed excursion of the club to the titaniferous rock areas of Nelson County, Virginia on May 3.

The following lectures were announced for the Bureau of Standards Physics Club during March and April:

March 10. *Materials and structural testing,* L. B. Tuckerman.

March 17. *The mechanism of electro-deposition,* W. Blum and H. S. Rawdon.

Three lectures on *Some high lights of visual psycho-physics,* by I. G. Priest as follows:

March 24. *The classification and nomenclature of colors.*

March 31. *General review of the leading principles of visual psycho-physics.*

April 7. *Equivalent stimuli and relations deduced from the laws of mixture of stimuli.*

The Washington, D. C., Chapter of the Wild Flower Preservation Society of America is planning to prepare a supplement to the flora of Washington and vicinity which was published in 1919, to include the species which have been found in this region since that time. Everyone who has reports of new finds to make is urged to send them in for inclusion in this supplement. Specimens should be deposited in the National Herbarium at the same time, if practicable. President, E. T. Wherry, Bureau of Chemistry; Secretary, P. L. Ricker, Bureau of Plant Industry.

Dr. F. L. RANSOME has tendered his resignation as geologist in the U. S. Geological Survey, to become effective May 16. He will continue his present work as head of the department of geology and mineralogy of the University of Arizona.

B. S. BUTLER, who has been engaged for several years past in the study of the copper deposits of the Lake Superior region, resumed work for the U. S. Geological Survey on April 16. W. S. BURBANK will be his assistant in field work in the Lake Superior region.

Dr. MANUAL GAMIO Director of the Department of Anthropology of Mexico lectured on *Archeological conditions of today and the future* at the Carnegie Institution of Washington, April 17.

Dr. THOMAS CORWIN MENDENHALL, physicist and educator, superintendent of the U. S. Coast and Geodetic Survey from 1889 to 1894, died at his home at Ravenna, Ohio, on March 23, 1924, at the age of 82.

The death of Prof. Fusakichi Omori, who was recognized as a leading authority in seismology, took place on November 8, 1923, in Tokyo. Born on October 30th, 1868, at Fukui, he entered the College of Science of the Imperial University of Tokyo, in his nineteenth year and studied physics until 1890, when he graduated from the college course. He then studied seismology and meteorology as a post graduate. In 1891 he became an assistant and in 1893 a lecturer on seismology. In 1895 he was sent to Italy and Germany for further researches, where he stayed two years. On the death of his teacher, Prof. S. Sekiya, Prof. Omori succeeded him in 1897 in the chair of seismology, which he occupied to the day of his death. In 1892, when the Earthquake Investigation Committee was organized by the government, he became a member of that Committee and served as its secretary after 1897; in 1917 he was elected as it's president. He was also a member of the Imperial Academy of Japan, Vice President of the Tokyo Geographical Society, Foreign Member of the Reale Academia dei Lincei, Roma, Foreign Member of the Washington Academy of Sciences, etc., etc. He was sent abroad often as a delegate to the International Conferences of Seismology and Geodesy. Recently, he visited Australia to attend the second Pan-Pacific Science Congress. His health declined steadily on his way home and he eventually passed away in the university hospital near his half damaged institute, where he spent the best years of his life.

His entire life was devoted to the investigation of seismology and vulcanology, the latter from the standpoint of physics, especially. His papers number more than one hundred each in English and Japanese, and are mostly contributed to the publications of the Imperial Earthquake Investigation Committee. On the basis of his early researches, he offered an explanation of the relation between the time and frequency of after-shocks of an earthquake. Later, with others, he described the relation between the duration of the preliminary tremors and the epicentral distances. He designed the well-known Omori's Horizontal pendulum tromometer, and discussed its theory and construction. He discussed also the similarity of the seismograms due to earthquakes of near origins. Studies of earth pulsation and earthquake zones constitute parts of his important works. He described and discussed many

destructive earthquakes at home and abroad and visited personally the fields of catastrophe in Assam, Kangra, San Francisco and Messina. All reports of these investigations were published in the Journal of the Committee. The paper on the variation of the mean sea level at the different tide guage stations in Japan and that on "Tsunami" or seismic tidal waves, are also the result of very interesting researches.

Beside the problems of pure physics, he turned his attention to the subject of applied science and measured the vibration of various kinds of buildings, bridges and piers, trains and ships with his special instrument. He also designed a deflectometer for bridges. He made several experiments on the overturning, sliding and fracturing of wooden and brick columns of various heights. Some observations on iron aqueducts resistent against earthquake shocks were made by him. These researches are said to have served to prevent or at least to diminish earthquake disaster on several occasions.

In the first and second decades of this century when many volcanoes of Japan renewed their activity, he took advantage of the opportunities to investigate the physical phenomena of these eruptions. Usu in Hokkaido, Asama in Central Japan and Sakura-jima in Kyushu were the most important subjects of his work. He also compiled many historical records of great catastrophies in Japan from ancient times to the present and published two large volumes on "*Japanese great earthquakes*" and "*Volcanic eruptions of Japan.*"

His death was indeed a great loss to Japan, especially in the period of the recent great disaster, when much aid of his knowledge and experience was demanded. His death is deeply lamented by all who knew him on account of his scientific attainments and his personal worth. It must be considered as the highest honour to a man of science in the land of his birth, that he was decorated with the highest order of the Sacred Treasure from the Imperial court, at the last moment of his illness. (Communicated by T. W. Vaughan.)

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 JUNE 4, 1924 No. 11

GENERAL SCIENCE.—*Some thoughts on old age.*[1] ERWIN F. SMITH, Department of Agriculture.

First of all: I thank you for the great honor you have done me. I have not attended the meetings of this Society very often in recent years because I have more things to do than formerly and especially because I have many things to finish and not much time left in which to finish them. My interest, however, remains the same. You are to be felicitated on your wonderful growth. I can remember when all the botanists of Washington might be gathered around one small table. That was 30 years ago. Now we fill a great banqueting room, and the end is not yet. I congratulate you especially on broadening out, so as to include research women in your membership. I am certain you will not regret it.

The Psalmist said: "The days of our years are three score years and ten; and if by reason of strength they be four score years, yet is their strength labor and sorrow, for it is soon cut off, and we fly away."

Another said: "When thou wast young, thou girdest thyself and walkedst whither thou wouldst: but when thou shalt be old, thou shalt stretch forth thy hands, and another shall gird thee, and carry thee whither thou wouldst not."

And the Preacher said: "All is vanity."

These are rather gloomy views of old age. I like better the view of Confucius. In recent years I have often thought of what is said in the Analects:

"The Duke of She asked Tsze-loo about Confucius and Tsze-loo did not answer him.

[1] Address delivered at the annual dinner of the Botanical Society of Washington, March 4, 1924.

"The Master said: 'Why did you not say to him—He is simply a man, who in his eager pursuit of knowledge, forgets his food, who in the joy of its attainment forgets his sorrows, and who does not perceive that old age is coming on?' "

Like the good master, I have been so happy in my work and so absorbed in it that I have not heeded the approach of age. One of my first intimations was when Whetzel, in his *History of Phytopathology,* discussed whether I belonged to the nineteenth century or the twentieth. Another intimation is such a program as this tonight.

Dr. Osler said a man should be chloroformed when he reached 60. Perhaps he was right; certain men should. We should now be in the League of Nations, no doubt . . . . I will let *you* finish the sentence. But Dr. Osler was only joking. He loved to joke and mystify, and in this case he must have chuckled hugely when the newspapers took him so seriously. Some of the best work of the world has been done by men over 60, as he knew very well. Elihu Root at 79, Dr. Wiley at 80, Dr. Keen at 84, and ex-President Eliot at 90 are still intellectually vigorous; and the world can ill afford to spare any one at 60 who is good for 80 or 90, and is not rotten timber. These four men, and I could name many others, have done more work since they were 60 than most men do in a lifetime, and have done it better. Wiley got the Pure Food bill through Congress after he was 60. Senator Morrill got through Congress the Land Grant Act establishing agricultural colleges when he was 63, and the second Morrill Act, increasing research appropriations for the same, when he was 78. Tennyson wrote his great triology, *Queen Mary, Harold,* and *Becket* after he was 65 and *Crossing the Bar* in his 81st year. Goethe studied Persian and wrote the *West-Oestliche Divan* when he was 65 and completed *Faust* when he was 82. Joffre was 63 when he won the battle of the Marne. Clemenceau was 65 when he became premier of France, and 79 when, with Woodrow Wilson and Lloyd George, he made the Treaty of Versailles.

From these remarks you may infer that I do not look kindly on the two bills now in Congress, one making the retirement age 60 and the other 65. They are engineered bills, designed to help individuals who desire promotion, and not to help the service. If you feel as I do, tell your congressman. Fifty is too long to keep some men in service, but why apply one yardstick to all? There are plenty of ways already of eliminating worthless individuals, and even those who are not worthless,

Tennyson makes the old Ulysses say:

> For my purpose holds,
> To sail beyond the sunset, and the baths
> Of all the western stars, until I die.

This is both good poetry and good philosophy.

Browning said in *Rabbi Ben Ezra:*

> Grow old along with me!
> The best is yet to be,
> The last of life for which the first was made.
> * * * * * *
> Youth shows but half: trust God: see all, nor be afraid!

I was very fond of quoting this once, but I was much younger then. Now it seems to me a part of that crass optimism Browning loved to indulge in. Personally, I do not contemplate old age with any great degree of pleasure. I envy those saints who can be ill and yet cheerful. They are usually women who have become confirmed invalids. They set noble examples, God bless them, which the rest of us may admire, even if we cannot imitate. But to be: "Sans teeth, sans eyes, sans taste, sans everything," as Shakespeare puts it, is hard to contemplate with equanimity. If, like Ulysses, one could work to the end and then die quietly without any fuss, old age would not be so bad. Nature meant us, I think, to drop off the tree of life like ripe apples from their twigs, but most men and women die prematurely with a vast deal of discomfort. We have not yet learned how to live, or how to die comfortably.

Here are some recipes for old age deferred. I thought some of you would be glad to have them.

First: Select your ancestors. This is the *best* one. I am sorry it is not more practicable. You are in for it personally and can't help yourself, but you may help your descendants tremendously by mating only into long-lived families. Especially, keep out of families with a history of tuberculosis and cancer. A good inheritance is certainly an immense factor in longevity, probably the greatest single factor. I realize it more and more. Almost all very old people come of centenary stock. Many of them abuse their bodies with tobacco and strong drink and yet live on and on. One of my great grandfathers, who died at 97, told me he had chewed tobacco for 90 years. If he had been temperate, I shudder to contemplate how long he might have lived, especially as he died of cancer of the cheek, undoubtedly due to tobacco. Smokers and chewers take warning!

Second: Avoid excesses. This recipe is practicable but more or less difficult, depending on the nature of one's inheritance and on his environment, that is, on his temptations. A fine ambition, hard work, and a pure love are strong safeguards. Good books and good company are other protections. Religion is another. Pitch will stick to whomsoever handles it. "Have no friends not equal to yourself," said the wise Confucius. He also said, "If a man will be virtuous one day, I have not known his strength to fail him," and by this he meant that we have to live and strive against the ape and the tiger in us *only one day at a time!*

Third: Keep cheerful, that is, don't worry. Worry kills more than work. Many persons, otherwise very lovable, are like Gretchen who was sent to the cellar to draw beer (the story is in Grimm's *Maerchen*). Since nobody reads German any more I may be permitted to tell the tale. As I recall it—it is a long time since I have read it—it runs as follows: Gretchen was sent to the cellar to draw beer. When she had turned on the spigot she happened to glance up at the ceiling and that was her undoing. She did not return. After a time, Hans, her lover, went down to see what had become of her and he did not return. Then the old woman went down and she did not return. Finally, the old man, becoming impatient and hearing a great hubbub in the cellar, went down to see what was the matter. He found them wailing and taking on as if they had lost all their friends, and, still worse, a great flood of beer was sweeping over the cellar floor. When the old man had stopped the waste of good beer and knocked a little sense into the heads of these three ninnies, he extracted from Gretchen, between her sobs, the following account: When she had looked up at the ceiling she saw an axe sticking into a beam, and she thought, "What a dreadful thing it would be if Hans and I should get married, and we should have a baby-boy, and he should grow up, and we should send him into the cellar to draw beer, and the axe should fall on his head and *kill* him—Boo-hoo-hoo!" The moral is don't cross bridges until you get to them. Many of them are only in cloudland; others are real, but your path will turn off suddenly and go in another direction. Be generous, and sociable, and altruistic, as well as cheerful, and these sentiments will react upon you and make you more cheerful. I have been accused of being proud and unsociable. It is not true! Say rather: "He is shy and absorbed, and the days are not long enough!" Be of a forgiving spirit. Most of my life has been spent delving into the printed history of things, isolating or inoculating parasites, looking into culture tubes

and flasks, or staring down the barrel of a microscope. It is a very laborious and exacting and at the same time a rather narrowing occupation, albeit a fascinating one. I have often said, jokingly, I would have gone into some other business if I had realized how much hard work I would have to do to get a *little* out of plant pathology.

Fourth: Cultivate the intellectual life. I believe that exercise of the intellect is an aid to longevity. How many philanthropists, statesmen, mathematicians, astronomers, physicists, chemists, geologists, physicians, and students of literature and the natural sciences have lived to be old. Their name is legion. Here are a few:

England: Sir W. Jenner (83), Soame Jenyns (83), Gladstone (89) John Bright (78), Wellington (83), Lister (85), Tennyson (83), Wordsworth (80), Frederick Harrison (92), Burdon-Sanderson (77), Berkeley (86), Bastian (78), James Montgomery (83), Sir Moses Montefiore (101), Isaac Disraeli (82), Benjamin Disraeli (77), Herbert Spencer (83), John Ruskin (81).

France: Voltaire (84), Buffon (81), E. Blanchard (80), Biot (88), Béchamp (92), Berthelot (80), Victor Hugo (83), Quatrefages (82), St. Simon (80), Chauveau (90), Dumas, the chemist (84), Delafosse (82), Desmazières (76), Boussingault (85), Van Tiegham (75), Ambrose Paré (81), Milne-Edwards (85).

Germany and Holland: Goethe (83), Von Recklinghausen (77), Ehrenberg (81), Leeuwenhoek (91).

Italy: Michael Angelo (89), Titian (99), Leo XIII (93), Galileo (78), Gentile Bellini (80), Giovanni Bellini (90).

United States: E. R. Hoar (79), Emerson (79), Davis (81), Alcott (89), Robert Collyer (89), S. Weir Mitchell (84), James D. Dana (82), W. J. Beal (91). You are all in the right class intellectually, if only you have a good inheritance behind you and will live simply and wisely, yet even with inherited handicaps some men have accomplished an enormous amount of work and lived beyond 70, e.g., Charles Darwin (73) and Louis Pasteur (73).

Fifth: Do not neglect the physical side. Breathe pure air, night and day; eat a good variety of plain foods and not too much. Don't worry about calories and vitamins. Do some physical work each day. Golf is for rich men; sawing wood, tending furnace, hoeing in the garden, housework, and botanizing are better exercises for such as we are. Botanizing is a more wholesome exercise than straight walking, because, like golf, it brings more muscles into action and at the same time keeps the mind interested. But straight walking is also good. How soon it dissipates a thousand gloomy fancies! Five or

ten miles a day ought to keep any scientific man in trim, unless he is a glutton, in which case there is no hope for him, here or hereafter, according to Dante. You remember how low down in his *Inferno* he puts them.

Sixth: Here are some of my own habits. My first acquaintance with Dr. Osler, then a great light in the medical firmament, was made just 30 years ago. I was sick, or thought I was, which sometimes amounts to the same thing, and Fairchild persuaded me to see Osler and went over to Baltimore with me. The great man looked at my tongue, felt of my pulse, listened to my heart, thumped and prodded me all over, and finally said, with a twinkle in his eye, "Doctor, you're all right *except here*," pointing to his head. Then he prescribed six months' vacation and 40 wet packs. Knowing how desperately hard he worked, I replied: "Why don't you take your own medicine, Doctor?" That was the beginning of our friendship which lasted as long as he lived, until 1920. I took six of his wet packs and swore off. The remedy seemed to me worse than the disease. As for six months' vacation on a salary $1600 (or was it $1800?), with half a dozen interesting pieces of work in progress, and Alfred Fischer to answer, that was wholly out of the question. Osler told me he worked like the devil nine months of the year but played the other three. I have not done that, but I have taken plenty of mental recreation, if not physical. I have learned it is not good to be jabbing forever on one set of brain cells. By spurts, a few months at a time, I have worked at certain subjects very hard, often 12 to 16 hours a day or more, i.e., all day and half the night, but always I have gone easily afterward for a while to recuperate, and one year with another, I have done a great deal of miscellaneous reading not directly related to my work—religious books (bibles, sermons, books of devotion, Christian, Stoic, Buddhist, Mohammedan); current literature; travels; histories; memoirs; autobiographies; letters; essays (Bacon, Montaigne, Carlyle, Emerson, and many others); poems (all sorts in half a dozen languages); plays (especially Shakespeare, but a little of Ibsen and Shaw,—yes, even Shaw—also Schiller, Hugo, Racine, and Molière—I have been very fond of Molière and of Synge, the Irish playwright); ghost stories; detective stories; novels and romances (Smollet, Fielding, Scott, Dickens, Thackeray, Hardy, Dumas, Hugo, Daudet, Cooper, Hawthorne, and many others); politics; logic; philosophy (Plato, Kant, Spinoza, Schopenhauer, Comte, Herbert Spencer, William James); Greek, Roman, and Indian mythology; Egyptology;

folk-lore; art criticism; general botany; entomology; archaeology; geology; astronomy; chemistry; medicine; and what not. All has been grist to my mill, with the exception of the higher mathematics, in which I have had no training. All knowledge has fascinated me. Like Browning's Grammarian, I would know all; even to the crumbs, I would eat up the feast. I read all of the 50-odd volumes of *Botanisches Centralblatt* one year. Beginning with the first article, I read all of the *Atlantic Monthly* for many years, not to mention a dozen other journals. And, it is safe to say, I have read one thing nobody else in this room has read, that is, the whole of the letter *C* in the *Century Dictionary*, only a matter of 800 pages. This I did to get their style of writing definitions before I began my work on Mycology for the first edition of the *Standard Dictionary*. I did it in four days and my head was in a whirl when I got through. I was never intoxicated with alcohol, but *this was a kind of intellectual drunk*, not to be commended.

The brain is a curious organ; no two subjects, I believe, bring into play quite the same set of brain cells, and by shifting interests the hard-worked cells of your specialty will have a chance to rest; otherwise, you will get neurasthenia, and especially if you worry. I have some reason to believe that the sub-division of labor in the brain is even greater than I have indicated, that is, that each language you learn involves a new set of cells and even that the past or future tense of a language does not exercise quite the same cells as the present tense. But enough of this.

Seventh: Finally, I am two persons in one, many persons in one, if I regard my ancestors. When I am sick I am a pessimist; when I am well, and that is generally, I am an optimist, and my optimism has grown upon me with advancing years until it is now perhaps a besetting sin, but I am pretty certain to die a pessimist, and that may compensate. Pessimism is due generally to bad digestion and to undue reflection on present miseries—a bad stomach is always an evil influence. Blessed is the man who can eat hard boiled eggs at midnight and sleep the sleep of the just. Yet the chances are he will not live out his span of life because some time he will presume *too much* upon his immunity. Optimism means good health, which should be the normal state of man, and still more it means altruism as opposed to egoism, and also, and especially, it means *a far-reaching outlook*, and faith in God and in the perfectibility of humanity. In an optimistic mood I wrote the following sonnet, with which I will close. It embodies the best of my philosophy of life. In it I have blended both my pessimism and my optimism, but optimism has the final word.

At 70

Backward I look from summit of the years
At the rugged dusty way of toil and grime,
From level distant plain of boyhood's prime,
—Way strewn with hopes, with triumphs and with tears:
And I am optimist, like him who hears
Clear voices call from higher peaks of Time,
Across the cloudy glens, and turns to climb
What yet remains, with more of hopes than fears.
I'm but a grain of sand upon Time's shore,
Driven by wind and waters evermore!
And *millions* make but shifting dunes and bars!
Yet I can read in every grassy sod
Divine great thoughts that sweep beyond the stars
And make me one with Him who is our God!

BOTANY. *New species of plants from Salvador. IV.* Paul C. Standley, U. S. National Museum.[1]

Abutilon vulcanicola Standl., sp. nov.

Shrub, 1.5–5 m. high, copiously branched, the young branches densely stellate-tomentose with yellowish, fine and coarse hairs; stipules caducous; petioles 2.5–9 cm. long; leaf blades orbicular-cordate, 10–18 cm. long and wide, abruptly acuminate, deeply cordate at base, entire or sometimes shallowly trilobate near the apex, green above, sparsely and very minutely stellate-pubescent or glabrate, paler beneath, densely and minutely stellate-pubescent; pedicels axillary, solitary, mostly 10–12 cm. long, jointed near the apex; calyx tube broadly campanulate, 1.5 cm. long, densely fulvous-tomentose, the lobes oblong-triangular, acuminate or attenuate, equaling the tube, reflexed, stellate-tomentose outside, densely whitish-sericeous within; petals orange, 4.5–6 cm. long, broadly obovate, recurved, coarsely stellate-pubescent outside; stamen tube 2.5 cm. long, glabrous above, enlarged and stellate-hirsute at base, the stamens very numerous; styles stellate-pubescent; fruit about 3 cm. in diameter, the carpels very numerous, rounded at apex, stellate-hirsute.

Type in the U. S. National Herbarium, no. 1,137,315, collected on the Volcán de San Vincente, Salvador, altitude about 1500 meters, March, 1922, by Paul C. Standley (no. 21514). Also collected on the same volcano, but on the opposite side, in March, 1922, by Dr. Salvador Calderón (no. 344).

A showy and handsome plant, quite unlike any species of *Abutilon* previously reported from Central America. The vernacular name is *malva.*

Hibiscus longipes Standl., sp. nov.

Plants apparently herbaceous, the branches covered with a dense stellate pubescence consisting of coarse spreading yellowish hairs and of finer appressed white ones; stipules subulate, 4–6 mm. long; petioles slender, 2.5–5

[1] Published by permission of the Secretary of the Smithsonian Institution. The last preceding paper of this series was published in the present volume of the Journal, pp. 93–99.

cm. long, densely and coarsely stellate-pubescent; leaf blades broadly ovate to rounded-ovate, 6–10 cm. long, 4–6 cm. wide, acute or obtuse at apex, cordate to truncate at base, shallowly crenate-dentate, thin, stellate-pubescent and rough on both surfaces, or glabrate above, the pubescence consisting of coarse 3-rayed hairs and of numerous much smaller and finer ones; pedicels axillary, mostly 5–9 cm. long; bractlets 8 or 10, slightly or much shorter than the calyx, oblanceolate or linear-oblanceolate, 2.5–4 mm. wide, acute, stellate-pubescent; calyx 2–2.5 cm. long, finely or coarsely stellate-pubescent, the lobes longer than the tube, lance-triangular, attenuate; corolla purplish, about 4 cm. long, the petals sparsely stellate-pubescent outside; capsule about 1.5 cm. long, very minutely stellate-pubescent; seeds densely covered on all sides with long soft silky hairs.

Type in the U. S. National Herbarium, no. 1,152,605, collected in the garden at the Finca San Nicolás, Salvador, in 1923 by Félix Choussy (no. 5). The following additional specimens have been examined:

SALVADOR: San Salvador, *Calderón* 820.

HONDURAS: Río Chamelecón, Departamento de Santa Bárbara, *Thieme* 5152.

Related to *H. lavateroides* Moric. (as which the Honduran collection was distributed), but distinguished by the much larger flowers. *Hibiscus lavateroides* is known at present only from eastern Mexico.

Malache fonsecana Standl., sp. nov.

Shrub, 1–2 m. high, the branchlets densely viscid-pubescent; stipules linear-subulate, 2.5–3.5 mm. long; petioles 1–2 cm. long, viscid-pubescent; leaf blades triangular-ovate or oblong-ovate, 3–5 cm. long, 1.5–2.5 cm. wide, gradually narrowed toward the attenuate apex, cordate at base, irregularly and shallowly crenate, glandular-viscid on both surfaces, green above and densely stellate-pubescent, pale beneath and stellate-tomentose; pedicels mostly axillary and solitary, 3–4 cm. long or longer, slender, viscid-pilose, jointed near the apex; bractlets 8–10, linear, green, 10–14 mm. long, densely glandular-pubescent; calyx 6 mm. long, scarious but green-nerved, viscid-setulose, the lobes ovate, acute, about equaling the tube; corolla densely pubescent outside; fruit 6 mm. in diameter, glabrous, dry, the carpels rounded at the apex, unarmed, obscurely nerved.

Type in the U. S. National Herbarium, no. 1,136,506, collected in dry thicket near La Unión, Salvador, on the Gulf of Fonseca, February, 1922, by Paul C. Standley (no. 20677).

Ayenia micrantha Standl., sp. nov.

Young branches slender, densely and minutely brownish-tomentose; petioles stout, 8 mm. long or less, nearly obsolete in the upper leaves, minutely tomentose; leaf blades ovate, 3–7 cm. long, 2–4 cm. wide, acute or acuminate, rounded or subcordate at base, coarsely crenate-serrate, above green and furnished with very minute scattered stellate hairs, beneath paler, finely and rather densely stellate-pubescent, 5 or 7-nerved at base; flowers in axillary fasciculate umbels, the peduncles 2–3 mm. long (sometimes up to 14 mm. in fruit), the pedicels 2–3 mm. long or in fruit often 8 mm. long; calyx minutely stellate-pubescent outside, the lobes ovate, 2 mm. long, acuminate, brown-purple and glabrous within; fruit (including spines) 6 mm. in diameter, sessile or nearly so, the spines very numerous and crowded, stout, scaberulous or glabrate.

Type in the U. S. National Herbarium, no. 1,151,926, collected near Chalchuapa, Salvador, in 1922 by Dr. Salvador Chalderón (no. 961).

Related to *A. jaliscana* S. Wats., a Mexican species, which is distinguished by its larger flowers, copious and longer pubescence, and the few short tubercles of the fruit.

Parsonsia salvadorensis Standl., sp. nov.

Plants erect, suffrutescent, 30–60 cm. high, sparsely branched, the stems densely covered with short stiff spreading hairs; petioles 3–9 mm. long, pubescent like the stems; leaf blades ovate-oblong or ovate, 2.5–5 cm. long, 1–2 cm. wide, acute or acutish, acute at base, thick, green on the upper surface and densely scabrous, somewhat paler beneath, scabro-hirtellous, especially along the nerves; flowers alternate, solitary in the leaf axils, short-pedunculate, the pedicel 5–6 mm. long, hirtellous, bearing at the middle 2 minute green bractlets; calyx stout, 28 mm. long, 5 mm. in diameter, bright red, densely and minutely hirtellous, the hairs somewhat thickened toward the base, the spur very short and broadly rounded, the tube glabrous within, not crested; calyx lobes all alike or nearly so, scarcely 2 mm. long, broadly ovate, acutish, ciliate, the cilia thickened at base, the appendages rounded-ovate, longer than the calyx lobes, greenish, ciliate with bulbous-based hairs; stamens 11, inserted about 23 mm. above the base of the tube; disk consisting of a short thick rounded dorsal projection; petals 2, bright red, clawed, the blades about 3 mm. long; capsule broadly oblong, glabrous, compressed, 7 mm. long, obtuse; seeds about 19, 2 mm. in diameter.

Type in the U. S. National Herbarium, no. 1,136,046, collected on edge of forest, near Finca Colima, Sierra de Apaneca, Departamento de Ahuachapán, Salvador, January, 1922, by Paul C. Standley (no. 20190).

Eugenia alfaroana Standl., sp. nov.

Shrub, 1–5 m. high, very densely branched, the branchlets very slender, thinly pilose-sericeous; petioles 2–4 mm. long, appressed-pilose; leaf blades linear or nearly so, often slightly broadened near the base, 5–6 cm. long, 1.5–4 mm. wide, acute at base, acute at apex and aristate-mucronate (bristle 1.5 mm. long), thin, when young thinly pilose-sericeous with whitish hairs, soon glabrate, paler beneath, finely glandular-punctate, the margins thickened and often revolute; pedicels axillary, solitary, 1.5–2 cm. long, very slender, appressed-pilosulous or glabrate; bractlets 2 at the base of the calyx, filiform-subulate, 2–3 mm. long; calyx tube 2 mm. long, densely white-tomentose, the lobes ovate, subulate-acuminate, 2.5–3 mm. long, tomentose or glabrate; petals broad, white, 3 mm. long, ciliolate, copiously gland-dotted; fruit purple-black, 6–7 mm. in diameter, glabrate; seed 1, about 6 mm. in diameter.

Type in the U. S. National Herbarium, no. 1,135,917, collected in open place at edge of forest on the lower slopes of the Sierra de Apaneca, Finca Colima, Departamento de Ahuachapán, January, 1922, by Paul C. Standley (no. 20053). The following additional collections are referable here:

SALVADOR: Departamento de Ahuachapán, *Padilla* 211, 330. Sonsonate, planted in a finca, *Standley* 22310.

Eugenia alfaroana is named in honor of Don Carlos Alfaro, in whose company the type specimen was collected, and to whom I am indebted for several days pleasantly and profitably spent at the Finca Colima, one of the most beautiful regions of Salvador and one of the most interesting botanically.

The plant is a relative of *Eugenia linearis* Rich. and *E. pomifera* (Aubl.) Urban. It is a handsome plant and is frequently cultivated in western Salvador. At Finca Colima the vernacular name was given as *pinito cimarrón* and at Sonsonate as *pino real*. Dr. Padilla reports the names as *ciprés* and *pino*.

Psidium rensonianum Standl., sp. nov.

Branches grayish, thickened and somewhat compressed at the nodes, when young very closely sericeous, soon glabrate; petioles stout, 5–8 mm. long; leaf blades elliptic to oblong or obovate, 5–10.5 cm. long, 2.5–5.5 cm. wide, obtuse or rounded at apex, acute at base, thick, green above and glabrous, the venation inconspicuous, beneath pale, very closely and finely sericeous (pubescence perceptible only under a strong lens) or in age glabrate, finely punctate, the costa prominent, the lateral nerves about 9 pairs, slender and inconspicuous, remote, laxly anastomosing near the margin; inflorescences axillary, 3–5-flowered, short-pedunculate, finely sericeous or glabrate, the pedicels stout, 3–6 mm. long; ovary minutely sericeous, the calyx densely brownish-sericeous, splitting into 5 irregular rounded lobes about 3 mm. long, these persistent upon the fruit; fruit glabrate, subglobose, 10–12 mm. in diameter, 1-seeded.

Type in the U. S. National Herbarium, no. 1,151,795, collected at San Salvador, Salvador, July, 1922, by Dr. Salvador Calderón (no. 838). *Renson* 339 from Salvador represents the same species.

Psidium rensonianum is probably related to *P. sartorianum* (Berg) Niedenzu, which, also, occurs in Salvador, but that species differs in its small leaves and lack of pubescence. The vernacular name of *P. rensonianum* is is given as *guacoco*.

Jacquinia longifolia Standl., sp. nov.

Shrub or small tree, 2–5 m. high, the branches slender, glabrous; leaves mostly alternate, but the uppermost often pseudo-verticillate, the petioles 3–5 mm. long, compressed, glabrous or minutely hirtellous, the blades narrowly oblanceolate-oblong, 5–7 cm. long, 8–17 mm. wide, obtuse or rounded at apex, not mucronate, gradually narrowed to the base, comparatively thin, green on both surfaces, glabrous or sometimes minutely hirtellous above along the costa, 3-nerved, the secondary nerves inconspicuous and laxly reticulate; pedicels solitary or fasciculate in the leaf axils, slender, thickened at apex, 4–5 mm. long (in fruit up to 8 mm.), glabrous; calyx 3 mm. long, glabrous, the lobes orbicular, obscurely crenulate and obsoletely ciliolate; corolla yellow, 7 mm. broad, the tube campanulate, 3 mm. long, the lobes suborbicular, two-thirds as long as the tube; staminodia rounded-oval, half as long as the corolla lobes; anthers cordiform, shorter than the appendages, obtuse, not emarginate, the filaments narrowly triangular; fruit ellipsoid, 1–1.5 cm. long, smooth, mucronate at apex, few-seeded.

Type in the U. S. National Herbarium, no. 1,136,970, collected in thicket on rocky stream bank at San Vincente, Salvador, March, 1922, by Paul C. Standley (no. 21159). *Standley* 21743, from the same locality, is also referable to this species.

Jacquinia longifolia belongs to the small group of species whose leaves are not pungent-mucronate at apex. It is not closely related to any of those previously described, all of which are natives of South America and the West Indies.

Ipomoea calderoni Standl., sp. nov.

A herbaceous vine, the stems slender, glabrous, bearing a few scattered compressed winglike tubercles; petioles slender, 11–14 cm. long, glabrous; leaf blades ovate-cordate to rounded-cordate, 11–15 cm. long, 7.5–11 cm. wide, acute and cuspidate-acuminate, with an acumen about 3 cm. long, deeply cordate at base, the sinus open, thin, glabrous throughout; peduncles axillary, solitary, recurved, 2–4-flowered, glabrous or bearing a few fleshy spinelike tubercles, the pedicels in anthesis about 2 cm. long, in fruit up to 5.5 cm. and much thickened (5–6 mm. thick beneath the calyx); sepals about 12 mm. long, ovate, coriaceous, glabrous, with thin scarious margins, cuspidate-acuminate at apex, the cusp greenish; corolla purple, slender funnel-form, the tube about 5 cm. long and nearly 2 mm. in diameter, the throat 2.5 cm. long, the limb about 3 cm. long, angulate; capsule 4-celled, oblong-ovoid, about 2.5 cm. long; seeds 4, glabrous, brown, 12 mm. long.

Type in the U. S. National Herbarium, no. 1,151,843, collected at San Salvador, Salvador, in 1922 by Dr. Salvador Calderón (no. 883).

Operculina hirsuta Standl., sp. nov.

A herbaceous vine, the stems scandent, sparsely long-hirsute; petioles slender, 6–9 cm. long, sparsely long-hirsute or glabrous; leaf blades rounded-cordate or broadly deltoid-cordate, 9–13 cm. long, 7.5–11 cm. wide, acute or acuminate, usually somewhat abruptly so, shallowly cordate at base, with a broad open sinus, the basal lobes broadly rounded, thin, glabrous; pedicels axillary, solitary 1-flowered, 3.5–4.5 cm. long, thick and stout (5 mm. in diameter below the calyx), glabrous, reflexed in fruit; sepals 2.5–3 cm. long, oblong-ovate, obtuse or rounded at apex, glabrous, green but with thin scarious margins; corolla pink, funnel form, 10 cm. long, the tube just above the calyx 10–12 mm. in diameter; capsule 2.5 cm. long, glabrous, 3-seeded; seeds strongly compressed, 12 mm. long, densely appressed-pilose, the margins thickly fringed with white silky hairs 1 cm. long or more.

Type in the U. S. National Herbarium, no. 1,152,316, collected in garden at San Salvador, Salvador, in 1922 by Dr. Salvador Calderón (no. 1338).

Easily recognized among the related species by the hirsute pubescence of the stems.

Cordia salvadorensis Standl., sp. nov.

Young branchlets sparsely hirtellous with spreading or partly appressed hairs; petioles slender, 1.5–3.5 cm. long, glabrate; leaf blades elliptic or oblong-elliptic, mostly 15–20 cm. long and 8–9.5 cm. wide, abruptly acute or acuminate, obtuse or acute at base, thin, deep green, remotely and shallowly sinuate-serrate above the middle or occasionally subentire, sparsely scaberulous on the upper surface, beneath scaberulous and along the nerves short-pilose, densely barbate in the axils of the nerves; flowers in lax, terminal or pseudo-axillary cymes, these few- or many-flowered, about 5 cm. long or in fruit as much as 15 cm. long, the branches scaberulous and hirtellous; flowers sessile or nearly so; calyx nearly 4 mm. long, scaberulous, finely multistriate, the 5 teeth very short, broadly triangular, obtuse; corolla tube varying from shorter than the calyx to slightly exceeding it, the lobes oblong, obtuse, glabrous, half as long as the calyx; fruit subglobose, 6 mm. long.

Type in the U. S. National Herbarium, no. 1,152,097, collected at San Salvador, Salvador, August, 1922, by Dr. Salvador Calderón (no. 1126).

Citharexylum macrocarpum Standl., sp. nov.

Tree of medium size, with rounded crown, the branches grayish, the young branchlets minutely whitish-puberulent; leaves opposite, the petioles 6–18 mm. long, puberulent, the blades elliptic, obovate-elliptic, or rhombic-obovate, 5–7.5 cm. long, 2.5–4.5 cm. wide, rounded, obtuse, or abruptly acute at apex, cuneately acute at base, green above, glabrous or puberulent along the costa, beneath paler, hirtellous, especially along the nerves, or soon glabrate, the blades rather definitely triplinerved, the secondary nerves prominulous and reticulate; flowers in slender few-flowered axillary spikes 1.5–2 cm. long, the rachis minutely puberulent; calyx in fruit 4 mm. long, glabrous, 5-costate, very shallowly 5-dentate, the teeth broad, obscurely mucronate; fruit apparently dry, 13–17 mm. long, 6 mm. broad, glabrous, somewhat compressed, oblong, soon splitting into 2 strongly compressed stones, each of these 2-celled and 2-seeded.

Type in the U. S. National Herbarium, no. 1,152,213, collected at La Cebadilla, Departamento de San Salvador, Salvador, in 1922 by Dr. Salvador Calderón (no. 1234). Here is to be referred also *Tonduz* 13792, collected in forests of the hills of Nicoya, Costa Rica, in December, 1899.

Although here referred to the genus *Citharexylum*, it is almost certain that this tree will be found to represent the type of a new genus. Unfortunately the flowers are lacking, and until they have been collected its status must remain doubtful. The fruit characters agree better with those of *Citharexylum* than those of any other genus of the Verbenaceae, but the fruit appears to be dry, and if such is the case, the tree will have to be placed elsewhere. It is probable that the flowers will be found to afford important diagnostic characters.

Physalis hylophila Standl., sp. nov.

Herb, 30–90 cm. high, much branched, the stems copiously viscid-villous with white hairs; petioles slender, 6–18 mm. long, viscid-villous; leaf blades ovate or ovate-elliptic, 2–4 cm. long, 1–2.5 cm. wide, abruptly acuminate, obliquely rounded at base, thin, entire, sparsely viscid-villous on the upper surface with short whitish hairs, beneath more densely villous with longer, mostly gland-tipped hairs; pedicels 3–5 mm. long, recurved in fruit, slender; calyx 3–4.5 mm. long, densely villous with short viscid hairs, the teeth short, broadly ovate, obtuse or acutish; corolla 6–7 mm. long, pale greenish yellow, the lobes ciliolate; fruiting calyx about 15 mm. long and 12 mm. in diameter, rather sparsely glandular-pubescent, obtusely 5-angulate, depressed at base, reticulate-veined, the teeth about 2 mm. long.

Type in the U. S. National Herbarium, no. 1,136,789, collected on a wooded slope along the shore of the Laguna de Maquigüe, Departamento de La Unión, Salvador, altitude about 60 meters, February 18, 1922, by Paul C. Standley (no. 20971).

The Central American species of *Physalis* have not been studied critically in recent years, but the present plant does not appear to be referable to any of the species described from that region or from Mexico. The vernacular name is *bombita*.

Tabebuia calderoni Standl., sp. nov.

A large shrub with thick trunk, the branchlets glabrate; petioles slender, terete, glabrous, 3–5 cm. long; leaflets 3, the petiolule of the terminal one about 2 cm. long, those of the lateral leaflets shorter, the blades oblong or ovate-oblong, 9–12 cm. long, 3–5.5 cm. wide, shortly obtuse-acuminate, obtuse or rounded at base, thick, lustrous above, glabrous, the venation elevated, beneath brownish (when dry), glabrous; flowers in terminal paniculate racemes, these about 10 cm. long, many-flowered, the rachis densely and minutely puberulent, the pedicels stout, 3–4 mm. long; bracts large and conspicuous but caducous; calyx campanulate, 5–6 mm. long, very shallowly 3-lobate, densely and very minutely puberulent; corolla yellow, about 4.5 cm. long, the limb 4 cm. broad, glabrous within, minutely lepidote outside, the lobes rounded-obovate.

Type in the U. S. National Herbarium, no. 1,165,688, collected at Acajutla, Salvador, July 13, 1923, by Dr. Salvador Calderón (no. 1666).

A very distinct species because of its combination of trifoliolate leaves and yellow flowers.

Aphelandra padillana Standl., sp. nov.

Shrub, 1–2.5 m. high, sparsely branched, the stems pruinose-puberulent and when young sparsely strigillose; leaves petiolate, the blades oblong-lanceolate or oblong-ovate, 15–25 cm. long, 4–9 cm. wide, acuminate, abruptly acuminate to the base and long-decurrent upon the petiole, thin, bright green above, bearing a few scattered short hairs, beneath paler, pruinose-puberulent; spikes stout, terminal and axillary, 12–30 cm. long, very dense, the rachis densely glandular-pilose; bracts closely imbricate, ovate or broadly ovate, 2–3 cm. long, obtuse or rounded at apex or the uppermost acutish, entire, green or purplish, densely glandular-pilose with short whitish hairs; flowers sessile, the bractlets linear-subulate, equaling the calyx, glandular-pilose; calyx lobes linear-lanceolate, 1.5 cm. long, long-attenuate, finely striate-nerved, finely glandular-pilose; corolla bright red, 6.5–7.5 cm. long, finely glandular-pilose outside, the tube nearly 5 cm. long, 7 mm. wide in the throat, the upper lip obovate, nearly 3 cm. long, obtuse or rounded at apex, the lower lip 3-parted, the segments lance-oblong, acute or obtuse; stamens exserted, the filaments glabrous or sparsely pilose, the anthers 4 mm. long; capsule 2 cm. long, elliptic-oblong, acutish, densely and finely pubescent.

Type in the U. S. National Herbarium, no. 1,135,839, collected along a stream in the mountains near Ahuachapán, Salvador, altitude about 1000 meters, January, 1922, by Paul C. Standley (no. 19972). The following additional specimens belong here:

SALVADOR: Ahuachapán, *Standley* 19771. Volcán de San Vincente, alt. 1500 meters, *Standley* 21512. Comasagua, *Calderón* 1364. Finca Chilata, Departamento de Sonsonate, *Standley* 19315. San Vicente, alt. 350 meters, *Standley* 21680. Santa Tecla, *Calderón* 1422.

Aphelandra padillana is named for Dr. Sisto Alberto Padilla of Ahuachapán, a keen student of the Salvadorean flora, to whom the writer is indebted for many favors during his visit to western Salvador in January, 1922. Dr. Padilla has published various articles upon the natural history of Salvador and other parts of Central America, and has forwarded to the National Museum a large collection of plants made by himself in the Department of Ahuachapán.

The species here described is a very showy plant that is common in the mountains of Salvador, but I have seen no specimens from other parts of Central America. It is a form well worthy of cultivation because of its handsome red flowers and attractive leaves. The only vernacular name obtained for it is *hierba de cadejo*, which was given me at Ahuachapán.

Justicia soliana Standl., sp. nov.

Slender shrub or herb, 1–2 m. high, much branched, the stems somewhat puberulent when young but soon glabrate; leaves slender-petiolate, the blades oblong-lanceolate to ovate, mostly 9–18 cm. long and 3–9 cm. wide, long-acuminate, abruptly acuminate at base and long-decurrent upon the petiole, thin, deep green above, glabrous, beneath paler, somewhat puberulent along the nerves but elsewhere glabrous, furnished on both surfaces with very numerous short raphids; inflorescence of numerous small thyrsiform panicles, these terminal and in the upper leaf axils, forming an elongate thyrsiform leafy-bracted panicle 10–30 cm. long, its rachis finely puberulent; bracts linear or linear-oblanceolate, 12–25 mm. long, green, obtuse or acute, minutely puberulent and near the apex usually, finely glandular-pilose, the bractlets similar but shorter and narrower; flowers sessile or nearly so; calyx segments linear-attenuate, subequal, 4–5 mm. long, finely puberulent; corolla bright red, 2.5–3 cm. long, densely short-pilose outside and with numerous short gland-tipped hairs, the tube straight, much longer than the lips, 4 mm. broad in the throat, contracted above the ovary, the lips subequal, suberect, the posterior one obscurely bidentate, the anterior one very shallowly 3-dentate; anthers unequally inserted, mucronate at base; capsule about 18 mm. long, clavate, glabrous; seeds 4, compressed, suborbicular, 3 mm. in diameter, muricate.

Type in the U. S. National Herbarium, no. 1,135,238, collected on a rocky stream bank at Finca Chilata, Departamento de Sonsonate, Salvador, December 26, 1922, by Paul C. Standley (no. 19325). The following additional specimens have been examined:

SALVADOR: Ahuachapán, alt. 1000 m., *Standley* 20009, 19777. Departamento de Ahuachapán, *Padilla* 13. Comasagua, *Calderón* 1408. San Miguel, alt. 110 m., *Standley* 21149. Finca Chilata, *Standley* 19313. Finca Colima, Sierra de Apaneca, Departamento de Ahuachapán, *Standley* 20056.

Justicia soliana is a handsome plant, very common in the mountain regions of Salvador, but I have seen no specimens from other parts of Central America. It is named for Sr. Don Salvador Sol, Minister of Salvador in the United States, to whom I am indebted for a pleasant visit to Finca Chilata, where the type specimen was collected.

Bouvardia pallida Standl., sp. nov.

Slender shrub, 1–1.5 m. high, the branches grayish, the young branchlets minutely puberulent; stipule sheath 2–3 mm. long, minutely puberulent, the free portion triangular, subulate-acuminate, glandular-laciniate; leaves mostly ternate, the petioles 2–3 mm. long, the blades lanceolate to narrowly ovate, 2.5–4.5 cm. long, 1–2.3 cm. wide, long-acuminate, acute or obtuse at base, thin, sparsely scaberulous or glabrate above, beneath paler, puberulent along the nerves; inflorescences terminal, cymose-corymbose, 5–12 cm. broad, many-flowered, dense, the bracts mostly large and leaflike, the pedicels slender, 2–4 mm. long, puberulent; hypanthium hemispheric, puberulent, the

calyx lobes oblong-linear, 2–3 mm. long; corolla lavender, glabrous, the tube stout, 5 mm. long, broadened upward, the lobes ovate-oblong, 3 mm. long, obtuse, glabrous within; filaments exserted; capsule subglobose, 3 mm. broad; seeds broadly winged.

Type in the U. S. National Herbarium, no. 1, 138,686, collected in a dry thicket on the lower slopes of the Volcán de San Salvador, above Santa Tecla, Salvador, April 7, 1922, by Paul C. Standley (no. 22977).

Related to *B. bouvardioides* (Seem.) Standl., a Mexican species, in which the corolla is twice as large and red.

Stylosiphonia salvadorensis Standl., sp. nov.

Slender shrub, 2.5–3.5 m. high, the branches terete, brownish, the young branchlets glabrous or sparsely pilose; stipules interpetiolar, 1.5–2 mm. long, deltoid, subulate-acuminate, persistent; leaves opposite, the petioles slender, 2–4 mm. long, sparsely pilose or glabrous, the blades lance-oblong, 3.5–6.5 cm. long, 1–2 cm. wide, rather abruptly acuminate, acute to attentuate at base, thin, bright green above, very sparsely pilose or glabrous, beneath paler, when young thinly floccose-tomentose, in age sparsely pilose, ciliate; flowers in few-flowered axillary cymes, the branches glabrous or nearly so, the peduncles about 5 mm. long, the pedicels slender, 5–8 mm. long, recurved in fruit; bracts linear, about 3 mm. long; calyx lobes linear-subulate, 2.5–3 mm. long; capsule ovoid, 5–6 mm. long, glabrous, costate, loculicidally dehiscent to the middle of the valves, the septum also cleft in dehiscence; seeds minute, brown angulate.

Type in the U. S. National Herbarium, no. 1,137,349, collected in moist forest on the Volcán de San Vicente, Salvador, altitude 1500 meters, March 8, 1922, by Paul C. Standley (no. 21559).

The flowers are not known, and the generic position of the plant is consequently doubtful, but it seems to agree better in fruiting characters with *Stylosiphonia* than with any other known genus of the Rubiaceae.

Verbesina salvadorensis Blake, sp. nov.

Stem obscurely pubescent; leaves alternate, obovate, acuminate, long-cuneate at base, very short-petioled, about 20 cm. long, 5 cm. wide, serrulate, strigillose but smooth to the touch above, sparsely pilosulous beneath chiefly along the nerves; heads medium-sized, radiate, white, in terminal flattish cymose panicles.

Herbaceous, at least above, probable tall and simple below the inflorescence; stem stout, subangulate, wingless, purplish-brown, sparsely short-pilose with chiefly appressed or ascending hairs, glabrescent except toward apex; leaves (only the upper seen) alternate, 1 to 3 cm. apart; petioles broad, naked, strigose, not auriculate or decurrent, 3 mm. long; blades obovate or oblong-obovate, 12.5 to 20 cm. long, 3 to 5 cm. wide, acuminate, gradually or somewhat abruptly narrowed into a long cuneate base, serrulate with low blunt teeth above the entire cuneate lower portion, papery, above deep green, finely lepidote-strigillose (the lepidote hair-bases persistent), beneath somewhat yellowish green, sparsely pilosulous on the veins and veinlets and sometimes slightly so on the surface, feather-veined, the costa whitish and prominent beneath, the chief lateral veins (above the narrowed basal part of the blade) about 10 pairs, whitish, prominulous beneath, the veinlets obscure; panicle flattish, pilose with appressed or loose hairs, about 22 cm. wide, equaled by the

upper leaves, composed of about 6 partial panicles terminating the stem and branches, these 5 to 10 cm. wide, many-headed; bracts linear or spatulate, mostly 2 cm. long or less; pedicels 2 to 10 mm. long; heads about 12 mm. wide; disk campanulate, 8 to 10 mm. high, 4 to 5 mm. thick; involucre about 3-seriate, graduate, 5 to 6 mm. high, the outermost phyllaries small, linear-lanceolate, with very short dark acutish tips, the others oblong or oblong-obovate, stramineous, acute or apiculate, ciliate, carinate and nearly glabrous dorsally, with subscarious appressed tips; rays 5, pistillate, white, the tube pilose, 2 mm. long, the lamina elliptic or oval, 2 or 3-toothed, 6 to 9-nerved, sparsely pilose dorsally, 4.5 mm. long, 2.2 mm. wide; disk corollas about 23, white, erect-pilose at base of throat, otherwise glabrous, 4.5 mm. long (tube 1 mm., throat funnelform, 3 mm., teeth ovate, 0.5 mm. long); pales narrow, acute or apiculate, ciliate above, 7 mm. long; achenes (immature) narrowly cuneate-obovate, about 4 mm. long, 1.5 mm. wide, very narrowly 1 or 2-winged, the wings ciliolate, decurrent on the base of the awns; awns 2, somewhat, unequal, 2 to 2.8 mm. long.

Type in the U. S. National Herbarium, no. 1,152,183, collected at La Cebadilla, Department of San Salvador, Salvador, in 1922, by Dr. Salvador Calderón (no. 1206).

A species of the Section *Ochractinia*, nearest the Guatemalan *V. punctata* Rob. & Greenm., which has the stems winged above with herbaceous wings up to 3 mm. wide.

ENTOMOLOGY.—*The North American bird parasites of the genus* Protocalliphora (*Calliphoridae, Diptera*).[1] RAYMOND C. SHANNON and IRENE D. DOBROSCKY. (Communicated by S. A. ROHWER.)

This paper deals primarily with the systematic treatment of the North American species of *Protocalliphora*, a genus of flies which, in the larval stage, parasitizes nestling birds. Swallows, crows, sparrows, larks, robins, and allied passerine birds are the usual hosts of these blood-feeding larvae, but the host record of an owl is also included below. Many nestlings are killed annually by these parasites. An extended biological account of the group will be given in a subsequent paper by the junior author.

Our native species have always been confused with the European forms. They may, however, be immediately separated therefrom by the absence of hairs on the post alar declivity and on the tympanic membrane (located between the inner margin of the lower squama and lower squama of post alar declivity).

Two names have been applied to American material: *Protocalliphora* (*Calliphora*) *splendida* Macquart, described 1845, has rarely

[1] We desire to express our appreciation to Drs. J. M. Aldrich, O. A. Johannsen and J. Bequaert for suggestions and material. For bibliography see Bezzi, Parasitology 14: 29–46. 1922.

been referred to in literature; the other, *P.* (*Phormia*) *metallica* Townsend, is apparently synonymous with *splendida*. Three North American species, besides several subspecies and varieties, are here recognized. A rather remarkable condition of sexual dichromatism is presented by this genus. *Protocalliphora sordida* of Europe is dark metallic blue in the male while the female is entirely of a bronzy cast. The species here called *splendida* Macq. seems to have several types of coloration in the female. One phase of the coloration is nearly as dark metallic blue as the male (probably the normal coloration); in another the tip of the abdomen is of a shining brassy hue (presumably a variation from the typical color, but this is the characteristic point in both Macquart's and Townsend's descriptions of their material—females in both cases); and a third phase is entirely bronzy, dull on the thorax and shining on the abdomen. The color of the squamae is also variable, being white in the majority of specimens, a deep and somewhat golden yellow in others, especially in the bronzy forms, and quite dark in certain specimens (both sexes) which occur in the West.

The dark form with tip of abdomen shining bronze (brassy) is apparently widely distributed throughout the United States. Representatives are at hand from New Hampshire, Virginia, Illinois, Wisconsin, Idaho, Washington, Oregon, and New Mexico. No doubt it also extends into Texas. It is fairly safe, therefore, to assume that Macquart's *splendida* (described from Texas) is conspecific with this form. Townsend's name *metallica* should then be considered as synonymous with *splendida*.

Probably more subspecies and varieties and even species exist in the *splendida* group but the external and genitalic differences have so little that is tangible it is deemed best not to recognize more than are here included. Perhaps additional rearings will give some clue to the differentiation of the forms. We do not yet know how specific the forms are for particular species of birds. In making observations on the habits of these parasites one particular point should always be noted, i.e., whether the larvae are living as endoparasites or whether they live externally and obtain blood by inserting only the mouth parts in the flesh. It is thought the species may behave differently in regard to this habit.

In the key to the genera of Calliphoridae[2] *Protocalliphora* and *Phormia* are separated from *Protophormia* and *Boreëlus* on the basis of possessing white squamae. Since specimens of *Protocalliphora*

[2] Ins. Ins Mens. 9: 107. 1923.

occur with dark squamae the character "disc of upper squama bare" may be used for *Protocalliphora* and *Phormia* and "disc of upper squama thinly pilose" may be used for *Protophormia* and *Boreëlus*.

KEY TO MALES

A. Narrowest width of front equal to length of third antennal joint; outer forceps subquadrate, less than twice as long as broad. *avium* (sens. lat.) n. sp.

a. Hairs on mesonotum one-fourth length of bristles; basicosta black. (New York).. *avium avium*

aa. Hairs of mesonotum nearly half as long as bristles; basicosta orange. (Washington).......................... *avium asiovora n. var.*

AA. Narrowest width of front distinctly less than length of third antennal joint; outer forceps elongate, three to four times as long as broad.

B. Parafrontals contiguous (may not hold for varieties *parva* and *cuprea;* our male of *parva* is without head, male of *cuprea* unknown). *hirudo* (sens. lat.) n. sp.

b. Accessory notopleural present (Colorado)........ *hirudo hirudo*

bb. Accessory notopleural absent (Kansas)... *hirudo parva. n. var.*

BB. Parafrontals well separated......*splendida* (sens. lat.) Macquart.

c. Dark metallic blue; pollinose stripes but little evident on mesonotal disc.

d. Squamae white (U. S. generally)....... *splendida splendida* Macq.

dd. Squamae darkened (Washington, Brit. Columbia). *splendida hesperia* n. var.

cc. Body with a general grayish tinge; pollinose stripes evident on disc of mesonotum (Washington)........ *splendida hirunda* n. subsp.

KEY TO FEMALES

A. Large species (11 mm.); parafacials broad, opposite second antennal joint equal in width to distance between oral vibrissae; basicosta dark brown.................................. *avium* (sens. lat.) n. sp.

a. Abdomen slightly pruinose (New York)........ *avium avium* n. var.

aa. Abdomen with ashy tinge (Washington)...... *avium asiovora* n. var.

AA. Smaller (9 mm. or less); parafacials usually narrower, opposite second antennal joint equal to one-half distance between oral vibrissae; if as broad as in *avium* then basicosta is orange.

B. Front unusually narrow; upper frontorbital absent; accessory notopleural present.......................... *hirudo* (sens. lat) n. sp.

b. General color dark, with rather heavy pruinosity.

c. Squamae darkened (Colorado).................. *hirudo hirudo*

cc. Squamae white (Kansas)................. *hirudo parva* n. var.

bb. General color bronze (Washington)........ *hirudo cuprea* n. var.

BB. Front normal; upper frontorbital present; no accessory notopleural. *splendida* Macquart.

c. Abdomen entirely dark blue.

d. Squamae white (Washington)........ *splendida hirunda* n. subsp. and (general U. S. distribution)........ *splendida sialia* n. var.

dd. Squamae darkened................ *splendida hesperia* n. var.

cc. Abdomen more or less coppery.

d. Entire body coppery (New Hampshire, Ontario) *splendida aenea* n. var.

dd. Last abdominal segment only coppery (general U. S. distribution........................ *splendida splendida* Macq.

Protocalliphora avium, n. sp.

Male: Large, robust, dark steely blue, with faint pollinose longitudinal vittae on mesonotum. Head broader than high, very broadly triangular in frontal aspect. Front rather broad, at narrowest width fully equal to length of third antennal joint; frontal vitta opaque black; parafacials shining silvery pollinose and bearing, besides the frontal bristles, black hairs which continue up to the vertical bristles. Upper parafacial shining silvery pollinose, opposite second antennal joint broader than distance between oral vibrissae. Antennae dark brown, third joint darker; arista about length of antenna. Mesonotum under proper reflection with two broad longitudinal pollinose stripes, confluent anteriorly; a somewhat similar stripe present on humeri and extending backwards. Legs black. Abdomen dark blue with greenish and violet reflections. Forceps shining black, outer ones subquadrate, less than twice as long as broad; inner forceps stout, diverging apically. Wings smoky, darker basally; squamae white. Length: 11 mm.; wing 9.5 mm.

Female: Front noticeably broader than length of arista; parafrontals and upper parafacials shining pollinose with a somewhat bronzy reflection. Mesonotum and abdomen more extensively pollinose than in male. Length 11 mm., wing 9 mm.

Three males and five females. Ithaca, N. Y. Reared from nestling crows, (Cornell University Lot 1033, 108 and 108 Aa, I. D. Dobroscky). Two females Ithaca, N. Y., July 10, 1914 (probably some of Coutant's material) are provisionally placed here.

Type.—Cat. no. 26857 U. S. N. M. Paratypes in Cornell Collection.

This species may be recognized in the male by the characteristic forceps, the outer ones being much broader than in all other species of the genus. The broad front of both ♂ and ♀ likewise serve to identify this species. Otherwise it is very hard to distinguish the female from certain varieties of *splendida*.

Protocalliphora avium var. **asiovora**, n. var.

Male: Differs chiefly in its darker coloration, lighter colored basicosta, longer mesonotal hairs and the outer forceps being less truncated apically.

One male, reared from larva found in a long eared owl's nest (*Asio wilsonianus*) McElroy Lake, Paha, Washington, June 30, 1920 (R. C. Shannon). A female specimen collected at Almota, Washington (A. L. Melander) is provisionally placed here. It scarcely differs from females of *avium avium*. The abdomen is more pruinose.

Type.—Cat. no. 26858, U. S. N. M.

Protocalliphora splendida splendida Macquart.

Male: Shining dark blue. Head somewhat broader than high; front narrowed, being noticeably less, at narrowest point than length of third antennal joint; frontal vitta opaque black; parafacials and parafrontals shining silvery pollinose; parafrontals squeezed out above, thus causing a cessation

of the setae a noticeable distance below ocelli; parafrontals opposite second antennal joint as broad as distance between oral vibrissae. Mesonotum and scutellum without very evident pollinosity. Legs black. Abdomen with only faint trace of pruinescence. Outer forceps elongate (1×5) slightly tapering downwards, apex obtusely rounded. Inner forceps slender, normally paralleled. Wings darkened basally, basicosta shining brown; squamae white. Length: 10 mm.; wing, 8 mm.

Female: (variety *splendida*). Front of medium breadth, about twice as long as broad and with full complement of bristles; frontal vitta opaque, parafrontals and parafacials rather dull silvery pollinose, a well defined somewhat bronzy changeable spot opposite basal antennal joints. Width of parafacials opposite second joint about two-thirds distance between oral vibrissae. Mesonotum appearing bluish gray due to rather extensive pruinescence which under different reflections breaks up into eight longitudinal vittae, heavier and somewhat confluent anteriorly. Apical tergite brassy, preceding ones dark bronze with pruinescence. Wings faintly, smoky, darker basally; basicosta dark brown; squamae white. Length 9 mm.; wing 7.5 mm.

The above descriptions of male and female are based on specimens reared from puparia found in the nest of a brown thrasher, Rosslyn, Virginia, May 20, adults emerged May 29, 1913 (R. C. Shannon). The female was included in the type material of *metallica* whereas the male was determined as "*Phormia chrysorrhea.*" Obviously they are male female of the same species, i.e., *splendida* Macquart. Although the female is probably atypically colored it must be considered as the typical form, it being the form described by Macquart. The distribution of all the subspecies and varieties of *splendida* is given at the end of the descriptions of this species.

Protocalliphora splendida sialia, n. var.

Female: Differs from *splendida splendida* in having the ground color of the entire abdomen deep shining blue. Usually the pruinescence of the mesonotum is less evident and the basicosta is very dark brown. This form is usually determined as *azurea* or *sordida* (*chrysorrhoea, caerulea*).

Protocalliphora splendida hesperia, n. var.

Male and female: Characterized by the dusky squamae and wing bases. The pile is also somewhat longer and usually more bristle-like on mesosternum.

Type.—Cat. no. 26861 U. S. N. M.

Protocalliphora splendida aenea, n. var.

Female: General color bronzy, mesonotum but little shining, abdomen well burnished; squamae and basicosta rather golden.

Type.—Cat. no. 26860 U. S. N. M.

Protocalliphora splendida hirundo, n. subsp.

Male: Forceps noticeably shorter than in *splendida splendida* and the outer ones in consequence broader in proportion to length. Front somewhat broader, the parafrontals well defined upwards until opposite lower ocellus. Basicosta yellowish brown; squamae white.

Female: Parafrontals and parafacials bronzy pollinose, without a well defined changeable spot; abdomen unicolorous; basicosta light brown; squamae white.

Type.—Cat. no. 26859 U. S. N. M.

HOSTS AND DISTRIBUTION OF PROTOCALLIPHORA SPLENDIDA MACQUART, (SENS. LAT).—Varieties *splendida* and *sialia*, reared specimens: 1 ♂, 2 ♀♀ (females: varieties *splendida* and *sialia*) host, brown thrasher (*Toxostoma rufum* L.) Rosslyn, Va., May 29, 1913 (R. C. Shannon); 1♂, 1♀ (female: variety *sialia*) larvae in nestlings of bluebird (*Sialia sialis* L.) Wellesley, Mass., August 10, 1907 (E. F. Everett); 1♀ (*sialia*) larva parasitic on nestling bluebird, Ottawa, Ontario, July 23, 1922 (H. Lloyd); 3 ♂♂, 3 ♀♀ (females, variety *sialia*), host, bluebird, Shawnee, on Delaware River, Pennsylvania, July 31, 1908; 8 ♂♂, 10 ♀♀ (females, variety *splendida*) host, cardinal, East Falls Church, Va., June, 1923 (E. A. Chapin); 2 ♂♂, 2 ♀♀ (females, variety *sialia*) host, robin (*Planesticus migratorius* L.) Ithaca, N. Y. June, 1922 (Shannon and Dobroscky); 30 ♂♂, 28 ♀♀, (*sialia*) hosts, crows and robin, Ithaca, New York, May, July (I. Dobroscky); 2 ♂♂, 4 ♀♀ (*sialia*) host, western horned lark (*Otocoris alpestris*) Koehler, Mew Mexico, Webster no. 7707 (W. R. Walton).

COLLECTED SPECIMENS: 1 ♀ (*sialia*), White Mountains, New Hampshire (H. K. Morrison); 1 ♂, 1 ♀ (*sialia*) Wellesley, Mass.; 1 ♂, Blue Hills Res., Mass., 1 ♀ (*sialia*) Blue Hill, Mass. (N. Banks); 1 ♂, on solidago, Stafford, Conn., August 24, 1905 (W. E. Britton); 1 ♂ McLean, New York, July 18, 1921 (R. C. Shannon); 1 ♂, Caroline, New York (E. G. Anderson); 1 ♂ Fall Creek, Ithaca, New York, April 26, 1922 (L. S. West); 1 ♂, Farmingdale, Long Island, New York, April 29, 1917 (J. Bequaert); 1 ♀ (*splendida*) Watchogue, S. I., New York, May 10, 1920 (E. J. Burns); 1 ♀ (*splendida*) West Orange, New Jersey (J. Bequaert); 1 ♀ (*splendida*) Robertson, Carlinville, Illinois; 1 ♀ (*splendida*) Milwaukee, Wisconsin; 1 ♀ (*sialia*) top of Las Vegas Range, New Mexico, 11,000 feet, end of June (T. D. A. Cockerell); 1 ♀ (*splendida*), Koehler, New Mexico (W. R. Walton); 1 ♀ (*splendida*) Moscow, Idaho, June 18, 1912 (J. M. Aldrich); 2 ♀♀ (*sialia*) Almota, Washington (A. L. Melander); 1 ♀ (*splendida*) Mt. Hood, Oregon, July 29, 1921 (A. L. Melander); 1 ♂, 2 ♀♀ (*sialia*) Savonoski, Naknek Lake, Alaska, August 1, 1919 (J. S. Hine).

Protocalliphora splendida aenea Shannon and Dobroscky. 3 ♀♀ Franconia, New Hampshire, (Mrs. Annie T. Slosson); 1 specimen, only mesonotum and wings remaining, probable ♀, "from brain of a living fledgling of sparrow kind," Ontario, (And. Halket).

Protocalliphora splendida hesperia Shannon and Dobroscky. A large series of this variety was reared from a number of species of birds in region of Seattle, Washington, summer 1918 (O. E. Plath). 1 ♂, 5 ♀♀, Ainsworth, British Columbia, July 11, 1903 (A. N. Caudell).

Protocalliphora splendida hirundo Shannon and Dobroscky. 35 ♂♂, 29 ♀♀, host, cliff swallow (*Petrochelidon albifrons* Say, many nests examined had dead remains of young), Stratford, Washington, July 4, 1920 (R. C. Shannon).

Protocalliphora hirudo n. sp.

This species (including the three varieties here recognized) is characterized by its smaller size, 8 mm., usually less, the unusually narrow front in both sexes (males always?), absence of the upper frontorbital in the female and the presence of an accessory bristle on the notopleura (except male of *parva*) which is smaller than and located between the usual two. Apparently only of western distribution.

Protocalliphora hirudo hirudo (sensu stricto)

Male: Entirely very dark shining blue; frontal aspect of head broadly oval, flattened on upper half; parafrontals contiguous; parafacials silvery pollinose, a slight trace of yellow present, equal to one-half distance between oral vibrissae; mesonotal vittae very faintly indicated; abdomen entirely shining; forceps very slender; wings and squamae distinctly smoky.

Female: Front about three times as long as broad; mesonotum and abdomen with perceptible pruinescence; wings and squamae smoky. Length 6–7 mm.; wing 6–7.5 mm.

Type.—Male, reared from nestling warbler, Colorado, July 10, 1911, (M. A. Palmer); allotype female (same, both from collection of W. R. Walton); paratypes: one male and three females (kindly loaned by Dr. J. Bequaert) reared from maggots found in sparrow Colorado Springs, Colorado, August, 1916 (W. W. Arnold); one male, two females, Koehler, New Mexico (Webster no. 7707, W. R. Walton).

Type.—Cat. no. 26862 U. S. N. M.

Protocalliphora hirudo parva n. subsp.

Male: Dark shining blue; forceps fairly long and slender; angle in last section of fourth vein not sharply angulated; basicosta light brown; squamae tinged. Length about 6 mm.; wing 5 mm.

Female: Head broadly oval, face but little protruding downwards; front narrow, nearly three times as long as broad; arrangement of frontorbitals abnormal, the upper one, on right side, opposite lower ocellus, upper one on left side absent, lower two pairs irregular in their relation to each other; parafrontals and parafacials somewhat ashy, without well defined changeable spot, at their broadest width, opposite second antennal joint, much less than width between oral vibrissae. Pruinescence on mesonotum extensive, giving a general ashy appearance. Wings as in male; squamae white. Length about 6 mm.; wing 5 mm.

Unfortunately the head is lacking in the male and the abdomen in female.

One male and one female, reared from fledglings, Kansas, (S. W. Williston through Prof. L. L. Adams).

Type.—Cat. no. 26864 U. S. N. M.

Protocalliphora hirudo cuprea n. var.

Female: Characterized by its general bronzy color and yellowish wing bases and squamae (coloration very similar to *P. splendida aenea*) and a pair of distinct pollinose mesonotal vittae. Length 7.5 mm.; wing 7 mm.

Reared from pupa in nest of western robin (*Planesticus migratorius propinquus*) Seattle, Washington (O. E. Plath).

Type.—Cat. no. 26863 U. S. N. M.

SCIENTIFIC NOTES AND NEWS

Dr. H. L. FAIRCHILD, of Rochester, New York, who accompanied the Marsh expedition to Darien, Panama, as geologist, visited Washington recently, returning in advance of the main party. Though none of the "blonde" Indians which were reported to exist in eastern Panama had yet been seen, a large amount of scientific data was gathered, and extensive collections of zoological and ethnological material were made. At the time Dr. FAIRCHILD left the base camp on the Chucunaque River about 50 miles from the coast the party was preparing to leave on a trip far into the interior.

The following officers were elected by the Anthropological Society of Washington at a meeting held April 15: *President,* TRUMAN MICHELSON; *Vice-president,* J. P. HARRINGTON; *Secretary,* JOHN COOPER; *Treasurer,* J. N. B. HEWITT.

PAUL C. STANDLEY, of the Division of Plants, National Museum, returned recently from a five months' trip to Panama and Costa Rica. Mr. Standley collected about 15,000 specimens of plants.

ATHERTON SEIDELL of the Hygenic Laboratory, has gone to Bordeaux, France, as an American delegate to the meeting of the Société de Chemie Industrielle.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 14 June 19, 1924 No. 12

GEOLOGY.—*On the geological age of the Walker Hotel swamp deposit, in Washington, D. C., and on the origin and the ages of the Coastal Plain terraces in general.* Oliver P. Hay, Carnegie Institution of Washington. (Communicated by G. P. Merrill.)

The first number of the current volume of the Journal contains four articles which describe a swamp deposit that is found in the city of Washington and is regarded as buried in the Wicomico terrace. The present writer will not delay to describe in any way this deposit and its fossil contents. This work was done by the authors of the papers in a manner worthy of the highest praise. Only with certain opinions assumed or expressed by some of the authors regarding the age of the Wicomico terrace and of the manner of its formation does the present writer take issue. The theory entertained by the authors of the papers referred to is essentially the one proposed by McGee and supported especially by Shattuck and other geologists of the Maryland Geological Survey. It is to the effect that for each terrace there was a submergence of the coast beneath the sea during which deposits were laid down along the new strand and distributed by the waves of the sea and its estuaries. According to McGee and Shattuck, the submergences affected the coast from about Staten Island to Florida and even to the Rio Grande; but the authors of the papers on the Walker Hotel deposit do not commit themselves on this point.

The present writer believes that it is unnecessary to suppose that the terraces along the coastal plain and its estuaries were built up by the sea. Terraces are found along nearly all of our great rivers. Furthermore, some of our ablest geologists believe that the coastal plain terraces are wholly, or almost wholly, the product of river action. I occupy no original position in the matter.

To the writer, the most convincing argument against the theory that the terraces were built up at sea level or below it, is found in the total lack of marine and estuarine fossils in them, except in some deposits near the present sea level.

In the Pleistocene volume of the Maryland Geological Survey this sentence is found: "The lack of abundance of fossils seems in a large measure to be due to unfavorable conditions for preserving the hard parts of animals which probably inhabited the estuaries and open water of the ocean in large numbers" (p. 102).

What are the probabilities that there was an abundance of marine animals living along the Atlantic and Gulf coasts during each of the submergences? Besides the forms of life which inhabit deep water, there are numerous species of fishes, mollusks, crustaceans, echinoderms, tunicates, and worms which live between tides or in comparatively shallow water. When, according to McGee's theory, as developed in his monograph,[1] illustrated by his maps, and accepted in principle by various geologists, the land from the Rio Grande north to Long Island or farther was depressed 500 feet, all the shallow water forms were compelled to move to the new strand or perish. The species occupying deeper waters undoubtedly would likewise migrate in the same direction. Inasmuch as all but a few per cent of the fauna that lived during the late Pliocene still lives, it is evident that all those marine animals inhabited the strand a hundred or two hundred miles from the present shore of the Atlantic and Gulf States and north to southern Illinois in the Mississippi embayment. Who can doubt then, that in that Lafayette marine terrace and its extension oceanward, if there was such a terrace, there were buried in abundance the remains of mollusks and fishes, besides the bones of roving cetaceans and turtles? When the coastal plain rose and the Lafayette sea was pushed back, the marine creatures retired with it; and we find that not long afterward their descendants left their remains in the early Pleistocene beds all along the present coast line. When, according to the same theory, the Sunderland depression of the land occurred, those marine tribes migrated to the Sunderland level and left their shells and skeletons in the sands and clays of that terrace. Can we doubt that somewhere during that time there were piled up beds of oyster shells such as were at some time laid down at Wailles Bluff, or strata of molluscan shells such as are to be found in the Pleistocene in Florida? A similar migration and return of

[1] U. S. Geol. Survey, Twelfth Annual Report, Part 1.

marine forms must be assumed to have occurred when the Wicomico terrace was laid down, and again the same changes of habitat and the same burial of fossilizable remains during the formation of the Talbot terrace.

We must consider the immense extent of time during which those terraces were submerged. If we allow 500,000 or 1,000,000 years in round numbers for the Pleistocene and then some thousands or hundreds of thousands of years for the Lafayette, it is evident that the construction of each terrace occupied a long period of time; and during this there was being entombed an abundance of fossil shells and bones, whatever may have become of them afterward. But, excepting again some of the deposits found now within a few feet of sea-level, not a scrap of all these creatures has ever been found in those terraces. That is admitted by the adherents of the theory. The explanation of this remarkable fact is that put forth in Professor Shattuck's sentence already quoted; that is, that the conditions for preservation have been unfavorable. That may be a sufficient explanation, but we should ask whether the conditions were unfavorable.

We must have in mind a coastal plain 2000 miles or more long and averaging probably more than 100 miles wide. During probably 500,000 or 1,000,000 years, parts of it were alternately dry land and sea-bottom. This plain was subjected to the influences of 4 or 5 glacial and a corresponding number of interglacial stages. During each of these stages the climate and the deposits at any locality depended partly on its position within 16 degrees of latitude and 25 degrees of longitude. Coarse sediments were poured into the sea by rivers rising in near-by glaciers or in more or less distant mountains. From other rivers, as the Mississippi and the great rivers of Texas, mud and fine sands were laid down. It is hard to believe that nowhere in approximately 200,000 square miles were mollusks buried under conditions that insured their preservation. At the end of the Wisconsin stage the sea entered Canada and Lake Champlain and in a small part of one glacial stage, laid down a formation which contains numerous molluscan shells, and the bones of whales, porpoises, and seals. If it be said that there has not been time for the dissolving of these shells, attention may be called to the beds of mollusks found from Dismal Swamp to southern Florida, which have resisted destructive agencies since the early Pleistocene.

There are, however, an abundance of fossils on all of those terraces from Staten Island to the Rio Grande, but these are not of marine, but of land animals, consisting of the bones and teeth of ground-

sloths, horses, tapirs, camels, deer, bisons, elephants, mastodons, and numerous other vertebrates.

It may be true that under the same conditions the shells of mollusks are more likely to be dissolved by the action of percolating rain-water than are the bones and teeth of land vertebrates. Nevertheless, the latter are more exposed to destruction than are marine mollusks. The skeleton of a land animal is usually exposed on the surface where decay is rapid. Only those skeletons which are soon covered up by water and earth are likely to be preserved, and of these only a few. It is probable that not one elephant in a million left any trace of itself, whereas of a bed of oysters, every shell may be preserved. The first process in the fossilization of a bone is the decay of the animal matter, leaving the mass porous and permeable to water. It may remain porous and little mineralized for thousands of years, unless dissolved. The molluscan shell is much more solid, is rarely exposed to the air, and is soon buried in mud.

But if the sea prevailed over the coastal plain terraces for thousands of years it is not mollusks alone that were buried there. There are marine as well as terrestrial vertebrates. In those seas were numerous fishes, large and small; there were porpoises and whales, and various species of vagrant turtles. The bones of all these would have been buried in the Lafayette, the Sunderland, the Wicomico terraces, as well as in the Talbot. Great and little sharks would have left their teeth in the deposits. The bones of a fish, of a porpoise, of a whale, or of a sea turtle, remaining in the water and soon covered up in mud, are far more likely to become fossilized than the bones of a land animal. The mass of fish bones produced on a coast must quite equal the mass of molluscan shells. While the sea was occupying successively the Lafayette, the Sunderland, and the Wicomico terraces, what had become of the Florida sea-cow, or manatee? Its large solid and heavy bones would certainly have been left somewhere on those terraces, possibly everywhere from the present coast to Montgomery, Alabama, and Vicksburg, Mississippi. Nevertheless, no bones of any marine fish, no teeth of sharks, no bones of porpoises, or of whales, none of sea turtles, or of the sea-cow, have ever been discovered in the Lafayette terrace, the Sunderland, or the Wicomico. It seems to me, therefore, that no shells and no bones of marine vertebrates are found there simply because they were never buried there.

How, then, were those terraces formed? It is the business of geologists to solve the problem; but in reaching their conclusions they must not ignore paleontology, not even vertebrate paleontology.

Before venturing any suggestions as to the manner of development of the terraces of the coastal plain, a consideration must be given to their age. The writer believes that all the terraces, except perhaps the Lafayette, are far older than has been supposed; and, to come to the point at once, he believes that the Talbot plain is of early Pleistocene age, probably of about the first interglacial state. This need not be taken to mean that no deposits whatever were laid down on it during later stages. The Wicomico and the Sunderland are of course still older. My reasons for believing that the Talbot is so old is that it contains, all along the coast from Staten Island to Mexico, what I regard as a first interglacial vertebrate fauna. This fauna is widely distributed over the peninsula of Florida and along the coast of Texas. In Florida it is best revealed at Vero, on the eastern coast at about the same latitude as Tampa Bay.

The lowest terrace in Florida recognized by Matson and Sanford[2] is the Pensacola, which rises from sea-level to about 40 feet. This elevation corresponds accurately with that of the Talbot of Maryland.[3] At the fossil-bearing locality near Vero, the surface is approximately 10 feet above sea-level. The bed which contains the oldest fauna is about 2 feet thick and is underlain by a stratum filled with Pleistocene mollusks and overlain by a bed of muck about 3 feet thick. The fossils are, therefore, near the surface. The most important species are a tiger, a saber-tooth tiger, a dog closely akin to one found at La Brea, California, a camel, two tapirs, three horses, a giant armadillo, two ground-sloths, and various tortoises. On the same plain, three miles distant and on the same geological level, *Elephas imperator* was found. Of the 29 species, 21 are extinct; that is, 72 per cent. The fauna is practically that of the so-called Hay Springs locality, on Niobrara River, Nebraska, and that of the Aftonian of western Iowa, the first interglacial. Unless some one is prepared to dispute the age of those fossils, we may ask what they are doing on that supposed late Pleistocene terrace? If they were buried at considerable depth it might be supposed that the deposit was laid down by a stream before the Sunderland stage and overlain by the seaward deposits of this and the succeeding terrace stages. Who can suppose, however, that the seaward deposits of the Sunderland, the Wicomico, and the Talbot, or their equivalents, would amount to only 2 or 3 feet of sand? Besides this, most of the deposit

[2] Florida Geol. Survey, Second Annual Report, 1913.
[3] Maryland Geol. Survey, Pliocene and Pleistocene, pl.

overlying the fossils mentioned is another stream-laid bed of sand, marl and muck full of the remains of a later land and fresh water fauna. It is evident that ever since early Pleistocene time there has been at that fossil locality a little stream which has not been disturbed by the three supposed submergences of the land and by perhaps as many uplifts of it above its present level and the consequent quickening of the stream which would have scoured those fossils out of their bed.

Farther north, in the vicinity of Brunswick, Georgia, a considerable number of fossil vertebrates has been found. In a canal made through a swamp, at a depth of 4 to 6 feet, there were found remains of the gigantic ground-sloth, *Megatherium*, elephant, horse, and bison. Beneath the clay bearing these fossils there was a bed containing sea shells. The relative position of the two beds appears to be the same here as it is at Vero, Florida. The same megatherium, a mylodon, three species of horses, a tapir, and other vertebrates were later dredged up in the harbor at Brunswick. The vertebrate-bearing stratum at this place has apparently been undermined by the river, as at Charleston. Farther north, at Savannah, on Skidaway Island within 3 or 4 feet of the surface and near sea-level, there have been found 7 species of vertebrates, all extinct, among them the two ground-sloths, *megatherium* and *mylodon*, and *Equus*. The bones present no indications of having been transported and redeposited.

The region about Charleston is rich in Pleistocene fossils. I have a record of 36 species, including mammals, of which 80 per cent are extinct. The bone-bearing bed is only a few feet above tide. While some species occur in place in this bed, most of those collected have been secured in dredging for phosphate rock and are mixed with species of Tertiary age. How this mixture has occurred does not matter, for there can hardly be a doubt that the Pleistocene fossils are all of the same age and have been derived from the one stratum. The species of most interest to us found at Charleston are an extinct genus of bear, two species of capybaras, *Elephas imperator*, a very large species of extinct bison, a camel, two species of peccary, three species of horses, the megatherium, and a mylodon. There appears to be every reason for regarding the fauna as equivalent to that found at Vero, Florida, and as belonging to the first interglacial stage. Here, as at Vero, it is on the equivalent of the Talbot terrace and at levels from a little below tide to 15 feet above it.

A few of the bones and teeth found in what appears to have been the original place of burial are somewhat water-worn; but usually

they are finely preserved. In the same stratum there may be an occasional marine vertebrate or mollusk. In a marshy locality at nearly sea-level, inhabited by many species of vertebrates and liable to inundations more or less prolonged, such commingling of species is not unnatural. There is no reason for supposing that there has been redeposition from an older to a more recent bed, excepting of course those fossils mingled with the phosphate.

Along the coast of North Carolina remains of Pleistocene mammals are not so abundant as farther south. Those discovered have been mostly elephants, mastodons, and horses. While these, so far as we know them, might have lived at a somewhat later time than the Aftonian, there is no necessity for supposing that they did. In a canal made through a swamp in Carteret County in a stratum of sand at a depth of 16 feet, elephant and mastodon bones were mingled with sea-shells. In this case, however, the mixture of bones, teeth and shells was probably produced by the excavating machinery. In a marl bed 16 miles below Newbern, besides various other species, were found remains of elephants, mastodons, and horses and other vertebrates mingled with sea-shells. The fossiliferous stratum nowhere rose more than 10 feet above the river. Whether the mollusks found here belong to the Pliocene or to the Pleistocene has been a subject of dispute. If not Pliocene, they are probably early Pleistocene and wherever the bones came from, they too must be of the same or earlier age. The deposit overlying the fossiliferous bed appears to have contained no fossils to show that it was of marine origin.

Along the coast of Virginia few fossils have been found that have a bearing one way or another on the age of the terraces. At Marshall Hall, on the Maryland side of the Potomac, there was found long ago a tooth of an extinct horse; at Georgetown, during the construction of the canal, other horse teeth were discovered. Inasmuch as no horses are known to have survived elsewhere as late as the beginning of the last drift stage, those teeth and the deposit containing them are put back at least into the last interglacial stage. There appears to be no reason why they are not as old as the first interglacial. At Chesapeake Beach in the low-lying deposits, the remains of bison, peccary, and horse have been found. All these appear to have been derived from the Talbot.

Some important discoveries have been made in New Jersey. Just above Camden on the Delaware, there occurs a bed of blackish clay from 20 to 25 feet thick overlain by 8 to 15 feet of sand. Long ago,

near the bottom of the clay and only about 10 feet above high tide, was found the skull of a horse. About 1896, other horse remains were found. Immediately below the level of the horse, there is a deposit containing numerous fresh water clams of the genera *Unio* and *Anodonta.* Salisbury and Knapp regard the clay bed and the underlying and overlying deposits as Pensauken, an extra-morainal deposit which appears to have been laid down about the time of the Aftonian or Kansan stages. The Maryland geologists regard it as belonging to the Cape May, equivalent to the Talbot. A few plants studied by Dr. E. W. Berry of the Maryland Survey caused him to conclude that the probability was strong that the beds were post-glacial in age.[4] It is remarkable that this species of horse, if of post-lacial age, had not pushed its way north to the fine pasture lands formed by the Wisconsin drift in New York, northern Ohio and westward. Furthermore, it is certain that the sea did not occupy that locality when the horses and the freshwater clams were living there. Nor is it probable that the 20 feet of blue clay was laid down in sea-water. As for the overlying sand, marine mollusks have never been reported from it. Even if those sands are of late Pleistocene age there is no sufficient evidence that they were deposited in water below sea-level.

For the following reasons the writer believes that the Fish House clays belong to the first interglacial, or Aftonian stage: 1. Our knowledge of the glacial and interglacial stages, of their relationships, characteristics, and distribution, rest on a more certain basis than does our knowledge of the terraces of the coastal plain. 2. On tracing the terraces to their contact with the glacial and interglacial deposits in New Jersey, it has been found impossible to correlate the two systems. 3. Competent geologists have identified the Fish House beds as early Pleistocene. 4. The conclusion that the Fish House beds belong to the first, or Aftonian, interglacial stage, is in harmony with our determinations of the age of the lowest terrace further south.

At Long Branch, New Jersey, a good many years ago, there was found a heel bone of the gigantic ground-sloth *Megatherium.* This animal has been already mentioned as occurring frequently in the southern States in deposits believed to belong to the early Pleistocene. While it would be impossible at present to prove that this animal did not live during the late Pleistocene, it is improbable that it did so. It may be supposed that there is present along that coast, not

[4] Torreya **10**: 262. 1910.

far below the surface, a stratum of Aftonian age which is being attacked by the sea. If it be affirmed that this Aftonian stratum is overlain by Cape May deposits, attention may be called to the fact that mastodon skeletons buried in peat have been exhumed near Long Branch. The most important of these was discovered 3 miles southwest of Long Branch and 2 miles from the coast. The locality must have been near the town of West Long Branch. The animal was buried in a deposit of black earth, evidently muck, 8 feet thick. The elevation is probably somewhat less than 50 feet. Two sections recorded by Salisbury and Knapp[5] show that the Cretaceous is within about 6 feet of the surface near West Long Branch. To this must be referred the marl mentioned by DeKay.[6] It is probable that the deposit belongs to the Cape May stage, but the muck and the mastodons do not testify strongly to marine occupation.

We ought now to consider briefly the origin of the broad trenches which are now occupied by the lower Potomac and by Chesapeake Bay, the estuary of the Susquehanna. These trenches, many miles wide and of great depth, if one measures from the Sunderland terrace to their ancient bottoms, now buried far beneath later accumulations, have at some time or times been excavated by river action. Occupancy by the sea would contribute to refilling the channels. These troughs must have been scoured out by rivers of immense volume and rapidity of flow. That they might accomplish this work of excavation, even their lower courses must have had some slope, and their sources must have been in elevated regions. Late in the Pliocene and in the early Pleistocene there was a period of uplift which seems to have affected the whole continent and determined the excavation of canyons, gorges, and wide and deep valleys. It was probably during this time of elevation that the estuaries and the terraced slopes of the now drowned lower portions of the Susquehanna and of the Potomac were carved out. The formation of terraces during such work as this would be a natural result. The excavation of the beds of these estuaries and the fashioning of the terraces was accomplished by the end of the first interglacial stage and since that time little change of level apparently has occurred.

Farther south, other rivers coming down from the mountains brought abundant clay, sand, gravel, and boulders to the coastal plain. Here, where the velocity of the streams was reduced, the

[5] New Jersey Geol. Survey 8: 200. 1916.
[6] Ann. N. Y. Lyc. Nat. Hist. 1: 143. 1824.

coarse materials would be dropped in fans; but at length the channels would be blocked and obliged to find new outlets at the sides, continually widening the fans. Fans of neighboring rivers would coalesce and make a continuous terrace-like plain. After perhaps another elevation of the mountains the streams would be quickened and another plain or terrace nearer the sea would be produced. On the southern part also of the coastal plain the terraces were essentially finished before the end of the first interglacial stage and the lowest one was ready to receive and preserve the bones and teeth of the animals which lived. Doubtless all of the terraces were afterward subjected to erosion and all received here and there some additions of material to their surfaces.

Unless, therefore, the writer is greatly in error regarding the history of the Pleistocene and its vertebrate life, the deposit and the fossils found in the Walker Hotel excavation are not only older than the Wisconsin drift and the Illinoian drift, but older than the close of the Aftonian. They may possibly be referred to about the beginning of the Aftonian.

In the Pliocene and Pleistocene volume of the Maryland Geological Survey, (pp. 96–100) Shattuck recorded a number of localities in Maryland where fossils which he refers to the Talbot have been found. Conspicuous among these are the remains of cypress trees. It seems to the writer that it is very probable that these vegetable remains are as old as those found in Washington. In several cases they are buried in a clay deposit which is overlain by sands and gravels which may have been laid down long afterward. At Bodkin Point the presence of casts of Unio shells shows that the water was not salt or brackish. At another locality (p. 99) a deposit of clay carries lignite and *Gnathodon* (*Rangia*) *cuneatus*, a shell now found not farther north than the Gulf of Mexico. At Wailles Bluff a considerable molluscan fauna has been collected. Is it not possible that this deposit is a continuation northward of the shell bed which further south underlies the Aftonian vertebrates and which the writer[7] has referred to the Nebraskan?

[7] Carnegie Inst. Wash. Publication 322, p. 15.

BOTANY.—*Identification of the commonly cultivated species of* Cucurbita *by means of seed characters.* PAUL RUSSELL, Bureau of Plant Industry. (Communicated by WILSON POPENOE.)

The genus *Cucurbita*[1] consists of ten species, all of which are possibly native to the New World, although authorities differ on this point. Seven of these species are perennial, and not cultivated in the United States, while the other three are annual. These are: *C. maxima* Duchesne, of which the Hubbard squash, the Delicious squash, and the Boston Marrow squash are examples; *C. pepo* L., of which the Large Yellow pumpkin, the Pie pumpkin, and the Summer Crookneck squash are examples; and *C. moschata* Duchesne, of which the Sweet Cheese (or Kentucky Field) pumpkin, the Japanese Pie pumpkin, and the Golden Cushaw pumpkin are examples. Besides these, many more varieties are cultivated in the United States. Among these the great diversity of size, shape, color, and character of flesh has made it difficult to determine to which species a given variety may belong.

In order to clear up this confusion, an attempt has been made to devise a key whereby the specific identity of any variety may be determined by means of the external characters of the seeds.

Some writers have included general notes on the seeds in the descriptions of these species, and one of them, C. D. Harz, gives[2] rather full descriptions of the seeds. None of them, however, has given sufficient data to permit a ready differentiation by means of seeds alone. The only mention of a seed scar is by Harz, who states (p. 813) that the seed of *C. pepo* has an oblique scar. Our experiments have shown that this is not the case, for the scar in this species is normally squarely truncate or rounded. (See Fig. 1.)

The work has been much simplified because of the fact, shown by Charles Naudin,[3] L. H. Bailey,[4] and J. P. Lotsy,[5] that these three species do not hybridize, although the varieties, within the species, often cross freely.

The field tests were carried on at the Arlington Experimental Farm, near Washington, D. C., in coöperation with the Department

[1] According to some authorities the use of the name "Cucurbita" should be confined to the species now generally known as *Lagenaria vulgaris* Ser., but since the purpose of this paper does not include a revision of the genus *Cucurbita*, the current usage is followed.

[2] Harz, C. D. Landwirtschaftliche Samenkunde. Berlin. 1885.

[3] Ann. Sci. Nat. Paris. Sec. Bot. 6: 59. 1856.

[4] Third Ann. Rept. Cornell, N. Y., Exp. Sta. 1890: 180–187.

[5] Genetica 1: 1–21. 1919.

of Agriculture. The following varieties were grown in 1922 and 1923. The species under which each is listed was determined by botanical characters other than those of the seeds, and the seeds of each group were subsequently studied for specific characters.

Cucurbita maxima: Arikara squash, Banana squash, Boer pumpkin, Boston Marrow squash, Delicious squash, Hubbard squash, Ironbark pumpkin, and Kitchenette Hubbard squash.

Cucurbita pepo: Cocozelle squash, Early Mandan squash, Large Yellow pumpkin, Mammoth Tours pumpkin, Pie pumpkin, and Summer Crookneck squash.

Cucurbita moschata: Charles Naudin squash, Chirimen squash, Courge bedouine, Faan Kwa squash, Golden Cushaw pumpkin, Japanese Pie pumpkin, Macleay River pumpkin, and Sweet Cheese (or Kentucky Field) pumpkin.

KEY TO THE ANNUAL SPECIES OF CUCURBITA

Fruiting peduncle finely ridged, not ribbed; leaves entire or but faintly lobed. . . . . *C. maxima.*

Fruiting peduncle strongly ribbed; leaves distinctly lobed.

- Apex of fruiting peduncle not enlarged, or but slightly so; calyx lobes narrow. . . . . *C. pepo.*
- Apex of fruiting peduncle much enlarged; calyx lobes usually broad, sometimes leaflike. . . . . *C. moschata.*

Cucurbita maxima was originally described[6] by Duchesne as follows:

Melopepo fructu maximo albo. Tournef. 106.
Cucurbita aspera, folio non fisso, fructu maximo albo sessili. J. B. 2. p. 221.
Pepo maximus indicus compressus. Lob. Ic. 641.
Pepo compressus major. Bauh. Pin. 311.
Cucurbita pepo. a. Linn. ?

The body of the description, which is in French, may be translated as follows:

The large-fruited pumpkin or gourd, *Cucurbita maxima* Duch.—This is very different from the other gourds; it is distinguished by the flowers being more widened or enlarged at the base of the calyx, with a reflexed limb, and by the large, rounded-heart-shaped leaves, borne on their petioles in an almost horizontal position. They are softer and their hairs less stiff than in the other gourds, somewhat resembling the leaves of melons. All parts of the plant are stouter and larger than those of the other gourds; the fruit, generally larger and more constant in its flattened-spherical form, has regular ribs and a considerable depression at each end; the pulp is firmer and at the same time juicy and melting; the skin is fine, like that of the Pâtissons. These are the chief characters of this species.

[6] Lamarck Encycl. 2: 151. 1786.

In amplifying the above, it may be said that the leaves of *C. maxima* are more or less kidney-shaped, faintly 5-lobed or altogether entire, never deeply lobed as in the other two species. The fruiting peduncle is cylindrical and finely ridged, never ribbed. The sepals are usually filiform, and the corolla lobes reflexed.

The original description[7] of *C. pepo* L., with its synonymy, is as follows:

> Cucurbita foliis lobatis, pomis laevibus.
> Cucurbita seminum margine tumido. Hort. Cliff. 452. Hort. Upsal. 291. Roy. lugdh. 263.
> Cucurbita major rotunda, flore luteo, folio asperso. Bauh. pin. 213.
> Cucurbita indica rotunda. Dalech. Hist. 616.

A free translation of the above, including the synonyms on which the species is based, would be "a cucurbit with lobed, rough leaves, yellow flowers, large, round, smooth fruits, and seeds with swollen margins." The species may be further characterized as follows:

The leaves are decidedly lobed and often deeply cut, the number of lobes being 3, 5, or 7. In many of the varieties the hairs on the petioles and lower surfaces of the leaves become very stiff and sharp. The calyx lobes are rather fleshy and subulate, never foliaceous. The corolla is very similar to that of *C. maxima*, except that it is rather less spreading. The fruiting peduncle is 5-ribbed, and never more than slightly enlarged at its point of attachment to the fruit.

Duchesne's original description[8] of *C. moschata* may be summarized as follows:

This species, very difficult to circumscribe, is made up of several varieties which have been too little observed to determine well. The plant is first mentioned by Chanvalon in his *Voyage de la Martinique*. Lamarck does not find sufficient differences to separate it as a distinct species. However, two differences may be noted, the contraction of the base of the calyx, and the close smooth down of the leaves. It resembles the calabash (*Lagenaria vulgaris*) in the whiteness of the flowers, the elongation of the green tips of the calyx, and the musky flavor of the fruit. The leaves resemble those of the gourds; they are angular or sharp lobed. The fruit is most often flattened; sometimes it is cylindrical, club-shaped or pestle-shaped; the color of the pulp varies from sulfur yellow to orange red. The fruit is cultivated like the calabash. In spite of its common name "musk melon," it furnishes only a mediocre fruit, rarely eaten raw; however, it is somewhat esteemed in the southern parts of France, in Italy, and in the islands of America. The fineness of its flesh and its good flavor make it preferred to most pumpkins.

The above description may be amplified by stating that the leaves are generally dark green and mottled with white at the angles of the principal venations. The calyx tube is much reduced, sometimes almost want-

[7] Sp. Pl. 1010. 1753.
[8] Dict. Sci. Nat. **11**: 234. 1818.

ing, and the sepals, instead of being subulate or filiform, are broader and very often leaflike. The fruiting peduncle is 5-angled and considerably swollen where it is attached to the fruit; it is less sharply angled than the peduncle of *C. pepo*.

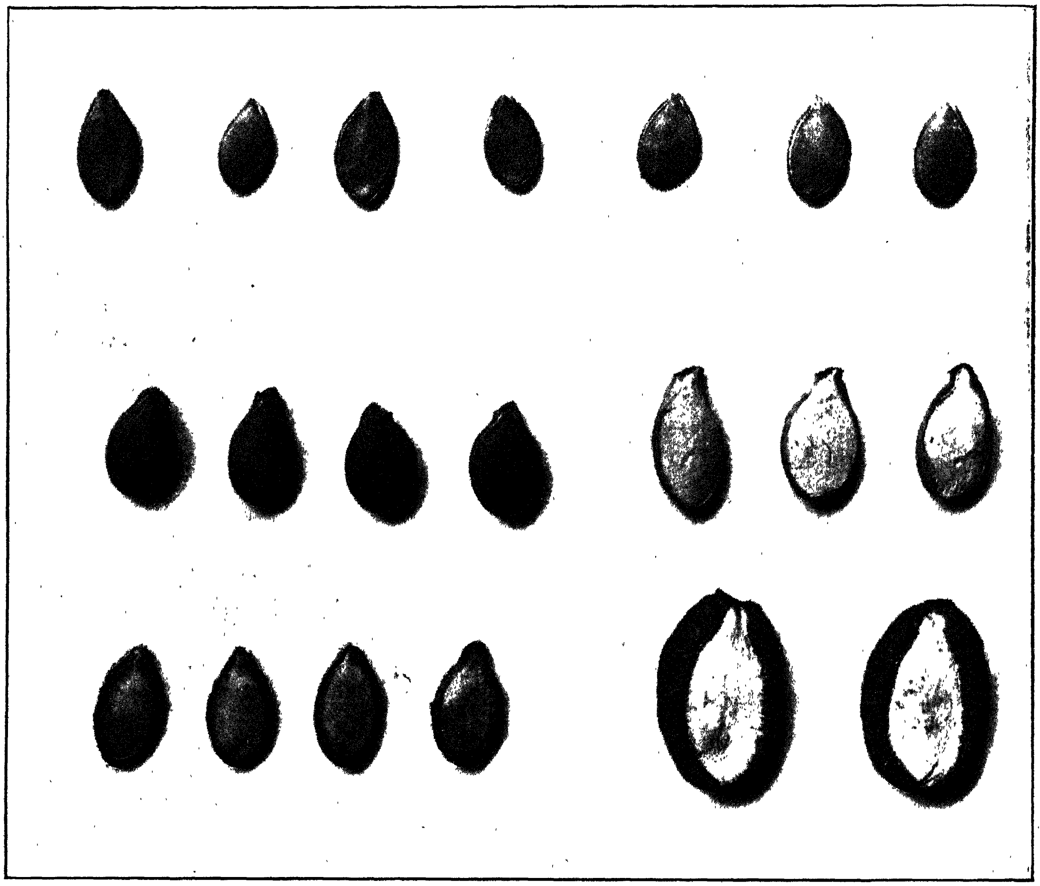


Fig. 1 Seeds of the commonly cultivated species of *Cucurbita*

Top row, Pie pumpkin (variety of *C. pepo*); middle row, two varieties of *C. maxima;* bottom row, two varieties of *C. moschata.*

As a result of the discovery of apparently constant specific characters in the seeds of the cultivated species of *Cucurbita*, it has been possible to name correctly over a hundred seed samples in the seed collection of the Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry. The following key should also prove valuable as a check on the identity and, to some extent at least, on the purity of commercial seed samples of varieties included in these three species.

KEY TO THE SEEDS OF THE ANNUAL SPECIES OF CUCURBITA

Scar obliquely truncate; face of seed pure white or clear brown .. *C. maxima.*
Scar normally squarely truncate or rounded; face of seed ashy gray or dirty white
  Margin agreeing in color with face of seed, usually smooth and not swollen.. *C. pepo.*
  Margin darker than face of seed, rarely smooth, often swollen and corky, or roughened and stringy............................ *C. moschata.*

The characters upon which this key is based are shown in the accompanying illustration (Fig. 1). The top row of seeds are of the Pie pumpkin, a good example of *C. pepo.* The middle row shows two varieties of *C. maxima;* the one at the left is the Ironbark pumpkin, from South Africa; the one at the right is the well-known Hubbard squash. Both of these show the oblique scar characteristic to *C. maxima.* The bottom row shows two varieties of *C. moschata;* the one at the left is the Faan Kwa squash, from China; the one at the right is Charles Naudin, from France.

In some cases it has been observed that immature seeds do not show the distinguishing characters, so that, for identification purposes, it is advisable to have mature seeds, and also to have several of a kind, in order to allow for unusual variations.

BOTANY.—*The genus* Forchammeria.[1] PAUL C. STANDLEY, U. S. National Museum.

In the course of work upon the Trees and Shrubs of Mexico, now in course of publication as volume 23 of the Contributions from the National Herbarium, the writer happened upon material of two Mexican plants belonging to distinct species but evidently congeneric, which it was impossible to refer even to a family, since they bore little general resemblance, apparently, to anything reported from Mexico. Recently, however, while examining a collection of plants obtained by O. F. Cook in Petén, Guatemala, there was discovered a fruiting specimen of a plant which was undoubtedly a relative of the Mexican ones, and their systematic position was recognized.

The Guatemalan plant was *Forchammeria trifoliata,* a species described from Yucatán, and based upon flowering material alone. The fruit had not been known previously, and proved to be so dissimilar from that of two common Mexican species of the genus that the close relationship existing between these three plants would not be apparent if their fruits were placed side by side. Study of the copious material of *Forchammeria* in the National Herbarium indicates that the species fall into two sharply marked groups, which may be

[1] Published by permission of the Secretary of the Smithsonian Institution.

treated as subgenera. The characters which distinguish them are indicated below in the key to species.

The difference in development of the ovary in these two groups results in fruits of two types so distinct that it might be advisable to treat *Helandra* as a generic unit; but on the other hand, the fruits are essentially the same in structure, and their final differences are due only to different modes of development. In *F. longifolia* I have seen a single fruit in which both cells developed equally, so that the seeds were vertical, and the stigma apical in a depression between the two cells, but such a condition was evidently abnormal, only one such fruit having been found among a hundred or more.

The form of the fruit in the subgenus *Helandra* is suggestive of that of the soapberry, *Sapindus saponaria*. The resemblance is so striking that at first it was believed that fruiting specimens of *Forchammeria longifolia* must belong to the family Sapindaceae.

Although placed by Bentham and Hooker in the Euphorbiaceae, *Forchammeria* is now referred to the Capparidaceae, where, however, it has no close relatives. It has had an interesting history, most of the few species having been described at long intervals. The genus is restricted, so far as now known, to Mexico, Guatemala, Salvador, and Hispaniola.

KEY TO SPECIES

Ovary 2-celled, one of the cells obsolete in fruit, not apparent externally, the fruit obovoid, the stigma remaining apical; seed vertical; staminate and pistillate inflorescences racemose; leaves simple. Subgenus **Euforchammeria.**

Leaves glabrous, oblanceolate or oblong............1. **F. pallida.**

Leaves hirtellous, especially beneath, linear.

Leaf blades emarginate at base; fruiting pedicels 3–5 mm. long; fruit 7–12 mm. broad......................2. **F. watsoni.**

Leaf blades usually attenuate at base; fruiting pedicels 10–15 mm. long; fruit 12–15 mm. broad........................3. **F. macrocarpa.**

Ovary 2-celled, only one cell developing in fruit, the other, however, slightly accrescent and forming a rounded protuberance at the base of the fruit, the latter subglobose, the stigma borne at the apex of the sterile cell and thus lateral; seed horizontal; staminate and pistillate inflorescences usually racemose-paniculate; leaves compound or simple. Subgenus **Helandra** (type species, *Forchammeria trifoliata* Radlk.).

Leaves compound, 1–3-foliolate, if unifoliolate the petiole jointed with the blade.

Leaflets narrowly oblanceolate-oblong, more than three times as long as wide; fruit 7–8 mm. in diameter......4. **F. longifolia.**

Leaflets obovate or obovate-elliptic, scarcely over twice as long as wide; fruit 10–12 mm. in diameter.

Leaves 3-foliolate; staminate inflorescence much branched. 5. **F. trifoliata.**

Leaves mostly 1-foliolate, rarely 2 or 3-foliolate; staminate inflorescence nearly simple.....................**6. F. sphaerocarpa.**
Leaves simple.
Leaves sessile or nearly so, the blades rounded or cordate at base **7. F. sessilifolia.**
Leaves petiolate, the blades attenuate at base.........**8. F. brevipes.**

1. **Forchammeria pallida** Liebm. Nat. For. Kjöbenhavn Vid. Medd. **1853**: 94. 1854.

Forchammeria apiocarpa Radlk. Meth. Bot. Syst. 54. 1883.

Western coast of Mexico, from Colima to Oaxaca. The type species of the genus.

2. **Forchammeria watsoni** Rose, Contr. U. S. Nat. Herb. **1**: 302. 1895.

Baja California, Sonora, and Sinaloa. Known in Baja California as *palo San Juan.*

3. **Forchammeria macrocarpa** Standl. Contr. U. S. Nat. Herb. **20**: 183. 1919.

Forchammeria purpusii Loesener, Repert. Sp. Nov. Fedde **16**: 204. 1919.

San Luis Tultitlanapa, Puebla. Both names are based upon the same collection.

4. **Forchammeria longifolia** Standl., sp. nov.

Shrub, about 2 m. high, with few stems, glabrous throughout; leaves partly unifoliolate and partly trifoliolate, the petioles of the former 1–2.5 cm. long, of the latter 2–3.5 cm. long; leaflets narrowly oblanceolate-oblong, 12–22 cm. long, 3–6.5 cm. wide, obtuse or acute, gradually attenuate to the cuneate base, coriaceous, the venation inconspicuous on the upper surface but slightly elevated beneath, the lateral nerves about 16 pairs; pistillate inflorescences clustered on old wood, racemose-paniculate, many-flowered, 10–15 cm. long; fruiting pedicels 3–8 mm. long; fruit yellow, subglobose, 7–8 mm. in diameter, smooth, sessile or nearly so, bearing at base a small rounded protuberance, the abortive second cell of the ovary; seed compressed-globose, 6–7 mm. in diameter.

Type in the U. S. National Herbarium, no. 568024, collected in woods, Pueblo Nuevo, Veracruz, near Tampico, Mexico, May, 1910, by Edward Palmer (no. 444). A second specimen of the same collection is mounted upon sheet no. 568025.

The leaves borne at the tips of the branches are trifoliolate, but the lower ones are unifoliolate. *Forchammeria longifolia* is evidently related to *F. trifoliata*, but is distinguished by the presence of numerous unifoliolate leaves, the long narrow leaflets, and the smaller fruit.

5. **Forchammeria trifoliata** Radlk. Field Mus. Bot. **1**: 399. 1898.

YUCATÁN: Izamal, *Gaumer* 417 (type collection).

GUATEMALA: Naranjo, *Cook & Martin* 65.

SALVADOR: Ahuachapán, *Standley* 20273.

In both Yucatán and Guatemala the tree is known as *Tres Marías.* The Salvadorean specimen, taken from a sterile shrub of 2 meters, differs slightly in the shape of its leaflets, but is probably conspecific.

6. **Forchammeria sphaerocarpa** Urban, Symb. Ant. **1**: 310. 1899.

Type from Jérémié, Haiti, *Picarda* 1308. Not seen by the present writer, but from the description evidently referable to the subgenus *Helandra.*

7. Forchammeria sessilifolia Standl., sp. nov.

Tree, 6–12 m. high, glabrous throughout; leaves sessile or nearly so, the blades oblong, sometimes slightly broadest above the middle, 14–19 cm. long, 4–9 cm. wide, obtuse or acutish at apex, cordate or rounded at base, coriaceous, the venation prominulous on both surfaces, the lateral nerves about 11 pairs; staminate flowers in lax, once or twice branched, many-flowered panicles borne on old wood, the panicles pedunculate, 10–20 cm. long or larger, the flowers partly sessile, but often on pedicels 3–7 mm. long; stamens 15–20, the filaments about 3 mm. long, the anthers subglobose.

Type in the U. S. National Herbarium, no. 908024, collected on María Madre Island, Mexico, May, 1897, by E. W. Nelson (no. 4239). A second specimen of this collection is mounted upon sheet no. 569214.

This species is well marked by its sessile leaves with broad bases. Although only the staminate plant is known, the general appearance indicates that it is of this alliance rather than a species of *Euforchammeria*.

8. Forchammeria brevipes Urban, Symb. Ant. **7**: 225. 1912.

Type collected in the Province of Barahona, Dominican Republic, at an elevation of 1300 meters, *Fuertes* 544.

A specimen of the type collection is in the National Herbarium, but it is in poor condition, although there is no doubt of its relationship. This is the only species of the subgenus *Helandra* in which the staminate inflorescences are not known to be paniculate, but those of the type material are so imperfect that one can not be certain as to their character.

EXCLUDED SPECIES

FORCHAMMERIA LANCEOLATA Standl. Contr. U. S. Nat. Herb. **20**: 183. 1919. Further study shows that this is *Drypetes crocea* Poit., of the Euphorbiaceae, a genus not reported previously from Mexico. The former name was based upon *Pringle* 3728, the locality of which was not known at the time the description was published. It is now known to have been collected in Tamasopo Canyon, San Luis Potosí.

SCIENTIFIC NOTES AND NEWS

The annual excursion of the Petrologists' Club was held on May 3. The party left Washington on the preceding evening by the Southern Railway and were met at Shipman, Virginia, by Prof. T. L. Watson, State Geologist of Virginia, who acted as guide. A trip was first made by autobus to the workings of the American Rutile Company near Roseland in Nelson County. This locality is on the eastern border of an area of syenite near its contact with the biotite-quartz monzonite gneiss which is the prevailing rock of this part of the country. Gabbro is also present along this border intergrading with the syenite. The titanium minerals rutile (TiO_2) and ilmenite ($FeO.TiO_2$) occur in these bordering rocks. They are extracted by crushing, washing, and magnetic separation. This locality is the principal source of rutile in the United States.

Two interesting features of the locality were Triassic diabase dikes cutting but not appreciably metamorphosing the rutile-bearing syenite; and dikes of nelsonite, an unusual rock consisting of apatite with rutile or ilmenite.

Returning to Shipman, the party proceeded north a few miles by the Southern Railway to Rockfish, where they were taken by a car of the Virginia Alberene Company by way of the branch railway to Schuyler, Virginia. Here the large quarries of the Alberene Company were visited. They are the source of practically all the soapstone used for laundry tubs, heaters, laboratory tables, etc. The rock is taken out in blocks by means of channeling machines and is then sawed into slabs, trimmed, polished, and assembled into commercial forms.

Ralph Edward Gibson, a graduate of the University of Edinburgh, has joined the staff of the Geophysical Laboratory as physical chemist.

Neil M. Judd, Curator of American Archeology, National Museum, left Washington on May 16 to resume direction of the explorations of the National Geographic Society at Pueblo Bonito. This prehistoric ruin, one of the largest and most important in the southwestern United States, is the most famous unit of the Chaco Canyon National Monument. The society began its explorations in Pueblo Bonito in 1921; it is hoped that the work will be concluded by the end of 1925.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 JULY 19, 1924 No. 13

MINERALOGY.—*An occurrence of iron-cobalt bearing gersdorffite in Idaho.* EARL V. SHANNON.[1]

A lot of material received for examination at the National Museum from Erwin Ploetzke contains a gray sulpharsenide of nickel, cobalt, and iron. The specimens were mailed from Burke, Idaho, and a letter accompanying them stated that they were from a prospect of Ploetzke in Idaho. Inquiries as to the exact locality met with no reply. Recently a similar lot of material was received from A. Beals of Avery, Idaho. An inquiry directed to Mr. Beals elicited the information that both lots were from the same prospect in which Mr. Ploetzke is a partner. It is located one mile above the mouth of Slate Creek, 7 miles from Avery. This is the first source of nickel minerals in Idaho. The deposits of the Blackbird district in Lemhi County are commonly referred to as cobalt-nickel deposits but, as a matter of fact, they contain almost no nickel. The Avery locality is in Shoshone County.

The specimens consist of greasy-appearing, greenish, sheared quartz containing the gersdorffite associated with pyrrhotite and chalcopyrite. The gangue contains a small amount of a grayish carbonate, probably ankerite. The quartz contains small open spaces lined with imperfect quartz crystals on which rest occasional whitish crystals of barite and minute pale-green globular or barrel-shaped aggregates of a scaly micaceous mineral. The latter is probably a chlorite. Optically, it is biaxial positive with 2V medium small, estimated at 30°, and refractive index is about 1.62. As a later deposit in the cavities there occur rose-red crusts of minute crystals of erythrite (cobalt bloom) too small to be measured but identified

[1] Published by permission of the Secretary of the Smithsonian Institution.

by their characteristic optical properties, and some dead-black material which may be heterogenite.

The gersdorffite appears to form masses up to several centimeters in diameter either pure or mixed with other sulphides. However, the mineral is not massive but consists of closely spaced small individual crystals, less than a millimeter in diameter, separated by quartz. Specimens may be selected which contain a large proportion of the mineral practically free from other sulphides. Several of these were crushed and sized by screening, and the quartz separated by methylene iodide. A few grains of pyrrhotite were separated with a hand magnet. Microscopic examination showed this prepared sample to be free from other sulphides. It was analyzed yielding the following results and ratios:

TABLE 1.—Analysis and Ratios of Gersdorffite from Idaho

Quartz	3.48			
Cobalt	9.09	0.154		
Nickel	14.28	0.243	0.586	1.02 × 1
Iron	10.57	0.189		
Arsenic	43.80	0.584	0.584	1.02 × 1
Sulphur	17.70	0.552	0.552	0.96 × 1
Total	98.92			

The ratios indicate the formula (Ni, Fe, Co) AsS with the ratios Ni:Fe:Co = 7; 5; 2 approximately.

Several crystals, isolated from the quartz, were measured and were found to be isometric combinations of cube and octahedron.

It is evident that the mineral is a member of the pyrite group and a sulpharsenide of nickel, iron and cobalt. It is thus a 3-component isomorphous mixture of the gersdorffite and cobaltite molecules with a hypothetical iron sulpharsenide not yet recognized as a distinct mineral. Since the gersdorffite molecule is definitely predominant over the others in the present mineral it may be designated gersdorffite.

The color of the mineral is steel-gray like arsenopyrite. After exposure it becomes dull and assumes a barely perceptible reddish tinge. In the closed tube it gives, like arsenopyrite, copious sublimates of arsenic sulphide and arsenic.

Polished surfaces of the ore, examined in reflected light, disclose the angular crystals of gersdorffite which have probably replaced the quartz metasomatically. Pyrrhotite occurs in a network of fine veins forming the matrix of angular quartz grains. The only

other metallic mineral present is white in color and is unattacked by the usual etching reagents including nitric acid and acid permanganate. This may be pentlandite. It is present in very small amount and bears the same relation to the quartz as the pyrrhotite.

The gersdorffite is resistant to all reagents except that, with long etching with acid permanganate, a faint zoning becomes visible by the slight darkening of certain layers in the crystals showing, probably, slight differences in composition.

The associated pyrrhotite, when separated and purified, contains a mere trace of nickel.

GENETICS.—*Do balanced lethals explain the* Oenothera *problem?*[1] STERLING H. EMERSON, University of Michigan (Communicated by H. H. BARTLETT).

It has been proposed by Muller (1917, 1918) and by Morgan (1918) that the balanced lethal explanation suggested by De Vries (1911, 1918) only to account for his double reciprocal crosses probably lies at the root of nearly all the unusual genetic phenomena of the Oenotheras. This view was supported by G. H. Shull, who reported at the Toronto Meetings of the American Association for the Advancement of Science in December, 1921, that he had proved the correctness of Muller's hypothesis. He stated that, with the exception of the short style of *brevistylis*, all the known genetic characters of *Oenothera* probably lie in a single chromosome pair. Since then data have been published to support this announcement (Shull, 1923-a, 1923-b).

Since the beginning of genetical studies on *Oenothera*, experimenters have been impressed with the striking correlations between various characters, and some breaks in these correlations have been noted. Emphasizing the idea that in *Oenothera* as well as in other organisms we are dealing with "unit" characters, Shull has concluded that all these characters, except the short styled condition of *brevistylis*, are associated in a single linkage group. In this group he has now located nine factors affecting visible characteristics, with which two zygotic lethals and two gametic lethals are assumed to be associated.

In reviewing the published data presented to demonstrate the behavior noted above, one finds considerable difficulty in harmonizing different portions of them, and is led to the conclusion that the proof for the balanced lethal hypothesis for the Oenotheras is by no means

[1] Papers from the Department of Botany, University of Michigan, No. 202.

certain. It will be the endeavor of this present paper to point out some of the discrepancies in the published results and show why they do not support that hypothesis. Thanks are due to Dr. Shull for amplifying the published data with regard to one or two points left doubtful by his publications, and also for reading the manuscript before publication.

DEMONSTRATION OF BALANCED ZYGOTIC LETHALS

To illustrate the behavior of balanced lethals, Shull (1923-a) has used a cross between *O. lamarckiana* and mut. *rubricalyx*, the former having green hypanthia, the latter red. In the first generation of this cross all the plants had red hypanthia but were of two

TABLE 1.—RESULTS OF RECIPROCAL CROSSES BETWEEN O. LAMARCKIANA AND MUT. RUBRICALYX.

CROSS	FIRST GENERATION	
	lamarckiana-like	*rubricalyx*-like
rubricalyx × *lamarckiana*	42	100
lamarckiana × *rubricalyx*	25	37
Total	67	137
Expectation (1:2 ratio)	68	136
FIRST GENERATION	SECOND GENERATION	
	Red hypanthia	Green hypanthia
9 *lamarckina*-like yielded a total of	396	0
10 *rubricalyx*-like yielded a total of	863	326

types with regard to growth habit, resembling one or the other of the parents. The second generation from *lamarckiana*-like plants bred true for red hypanthia, whereas the progeny from *rubricalyx*-like plants showed segregation into a class with red and one with green hypanthia. The actual results are reproduced in Table 1.

This cross was explained by Shull on the basis that *O. lamarckiana* carried the balanced zygotic lethals l_1 and l_2 (noted by De Vries, 1918), and that mut. *rubricalyx* carried but one of these lethals, since a homozygous form, *latifrons*, continually segregates from mut. *rubricalyx* in a 1:2 ratio (Shull 1923-b). *Latifrons* is assumed to lack lethals. These genetic constitutions will explain the composition of the first generation. But with such constitutions, both types of the F_1 of *lamarckiana* × *rubricalyx* should breed true except

for cross-overs, and with crossing over, both should show segregation. This, however, does not happen. This cross may be diagrammed as in Table 2.

From Shull's data for this cross one might assume that both l_1 and l_2 entered from the *rubricalyx* parent and only l_1 from *lamarckiana*. Diagrammed on this basis the results would be as shown in Table 3.

This arrangement allows for some of the first generation plants to breed true and others to give segregating progenies; but there are two objections to it. In the first place, this distribution of lethals is contrary to that found by De Vries for *O. lamarckiana* and by Shull (1923-b) and De Vries (1919) for mut. *rubricalyx* and the similar types, *rubrinervis* and *erythrina*. In the second place, the splitting forms should be *lamarckiana*-like and the non-splitting form should be *rubricalyx*-like. De Vries (1919) has shown that mut. *rubrinervis* carries the normal *velutina* gamete (or chromosome) of *O. lamarckiana* with its characteristic lethal l_1, but that the *typica* component has mutated to *deserens*, which lacks the lethal l_2. *Rubricalyx* is a mutation from *rubrinervis* in which the *deserens* component has mutated to a state that may be called *latifrons*. In Tables 2 and 3 the gametes are named and the factorial compositions of the gametes are listed. The genetic behavior of any combination is determined by the factorial constitution while the resemblance of any plant to *O. lamarckiana* or to mut. *rubricalyx* is presumably indicated by the chromosomes present in that plant.

Since noting the irregularities set forth above, it has been the writer's privilege to correspond with Professor Shull, who now believes the *lamarckiana* plant used in his cross had in some manner lost the lethal l_1 from the *velutina* chromosome. On this last assumption the cross appears as in Table 4.

It is a little more difficult to predict the appearances of the different genotypes on this hypothesis. Here the *velutina-velutina* combination is not eliminated by lethals, and if it reached maturity it probably would differ from *rubricalyx* in growth habit. The *typica-latifrons* combination, however, probably would resemble *lamarckiana*. In De Vries' crosses of *O. lamarckiana* and mut. *rubrinervis* (De Vries, 1919), three F_1 types were noted, *lamarckiana*, *rubrinervis*, and *lucida*, the last corresponding to the *typica-latifrons* combination of the present cross, and resembling *lamarckiana*. The *velutina-velutina* combination was lethal in De Vries' experiments.

TABLE 2.—A Diagram (Based on Shull 1923-a) Showing the Genetic Behavior of Crosses between O. lamarckiana and Mut. rubricalyx if lamarckiana carries l_1 and l_2 and rubricalyx only l_1.

Parents	Gametes	First generation	Second generation: Homozygous red	Second generation: Heterozygous red	Second generation: Homozygous green
lamarckiana × *rubricalyx*	(*velutina* rl_1	rl_1-Rl_1 (*velutina-velutina*) dies			
	(*typica*) rl_2	rl_1-R (*velutina-latifrons*) *rubricalyx*-like	1	2	Dies
	(*velutina*) Rl_1	rl_2-R (*typica-latifrons*) *lamarckina*-like?	1	2	Dies
	(*latifrons*) R	rl_2-Rl_1 (*typica-velutina*) *lamarckiana*-like	Dies	2	Dies

TABLE 3.—A Diagram Showing the Genetic Behavior of Crosses between O. lamarckiana and Mut. rubricalyx if l_1 is Carried by Lamarckiana and l_1 and l_2 by Rubricalyx

Parents	Gametes	First generation	Second generation: Homozygous red	Second generation: Heterozygous red	Second generation: Homozygous green
lamarckiana × *rubricalyx*	(*velutina*) rl_1	rl_1-Rl_1 (*velutina-velutina*) dies			
	(*typica*) r	rl_1-Rl_2 (*velutina-latifrons*) *rubricalyx*-like	Dies	2	Dies
	(*velutina*) Rl_1	r-Rl_2 (*typica-latifrons*) *lamarckiana*-like?	Dies	2	1
	(*latifrons*) Rl_2	r-Rl_1 (*typica-velutina*) *lamarckiana*-like	Dies	2	1

TABLE 4.—A Diagram (after Shull) Showing the Genetic Behavior of Crosses between O. lamarckiana and Mut. rubricalyx if l_2 Is Carried by lamarckiana and l_1 by rubricalyx

Parents	Gametes	First generation	Second generation: Homozygous red	Second generation: Heterozygous red	Second generation: Homozygous green
lamarckiana × *rubricalyx*	(*velutina*) r	r-Rl_1 (*velutina-velutina*)	Dies	2	1
	(*typica*) rl_2	r-R (*velutina-latifrons*) *rubricalyx*-like	1	2	1
	(*velutina*) Rl_1	rl_2-R (*typica-latifrons*) *lamarckiana*-like?	1	2	Dies
	(*latifrons*) R	rl_2-Rl_1 (*typica-velutina*) *lamarckiana-like*	Dies	2	Dies

The only conclusions that can be drawn from this experiment is that the data obtained do not demonstrate the action of balanced lethals. No checks were made to ascertain what lethals were present and as a result there is not one lethal factor in the cross that can be definitely recognized.

EXPERIMENTS TO SHOW LINKAGE AND CROSSING-OVER

Cross involving red hypanthia and revolute leaves.—Mut. *funifolia,* a revolute-leaved, green-budded mutation from *O. lamarckiana,* (Shull, 1921) was crossed with the flat-leaved, red-budded mut. *rubricalyx,* (Shull, 1923-b). The first generation consisted of two types, one resembling *O. lamarckiana,* the other mut. *rubricalyx,* but all had flat leaves and red hypanthia. These two types gave second generation progenies as indicated in Table 5.

TABLE 5.—F_2 FREQUENCIES IN THE CROSS MUT. RUBRICALYX × MUT. FUNIFOLIA

FIRST GENERATION	SECOND GENERATION			
	Flat leaves		Revolute leaves	
	Red hypanthia	Green hypanthia	Red hypanthia	Green hypanthia
3 *lamarckiana*-like	187	0	1	0
4 *rubricalyx*-like	277	8	4	98
1 *rubricalyx*-like	41	9	14	6

Shull's hypothesis was that mut. *funifolia,* like *O. lamarckiana,* carried both l_1 and l_2, and mut. *rubricalyx* only l_1. This assortment of lethals again brings in the same difficulties discussed under the preceding cross. Back-crosses were made with both F_1 types to the double recessive hyb. *erythrina funifolia.* As mut. *erythrina* supposedly has the same lethal factors as mut. *rubricalyx,* it would be hard to predict what lethals were carried by the hybrid *funifolia* used in this back-cross.

Since the explanation of this experiment involves crossing over between lethals and the factors for revolute leaves and red hypanthia, and since it is not known just what lethal factors are present in each case, the data are not of much significance even in showing the relation between the revolute factor and that for red hypanthia.

Cross involving red hypanthia and sulfur flower color.—When *O. franciscana* hyb. *sulfurea* was crossed with mut. *nanella* hyb. *rubricalyx* (Shull, 1923-b), the first generation consisted entirely of plants with red buds and yellow flowers. Six F_2 families gave a total of

581 plants with red hypanthia and yellow flowers, 6 with red hypanthia and sulfur flowers, 34 with green hypanthia and yellow flowers and 43 with green hypanthia and sulfur flowers. The deficiency in the sulfur-flowered classes was attributed to the presence of an egg lethal linked with the factor for sulfur flower color which had been introduced into hyb. *franciscana sulfurea* from its *O. biennis* parent when the cross was made by Davis, (Davis 1916). Davis, however, used *O. biennis* as the female parent, eliminating the possibility of the entrance of an egg lethal. Furthermore, if a pollen lethal instead were concerned, there would be 15 per cent crossing over between such a lethal and the sulfur factor. In this case the normal *O. biennis*, when imbred, should throw 15 per cent sulfur flowered forms; however, only four (Stomps 1914) sulfur flowered plants have appeared in the many thousands of *O. biennis* plants grown in culture. The zygotic lethals presumably carried by mut. *nanella* hyb. *rubricalyx* were not considered. If they were present they should decrease the number of plants in the double dominant class of the second generation and the data would be still farther from agreement with the hypothesis.

Other crosses.—In the back-cross (mut. *funifolia* × mut. *nanella* hyb. *sulfurea*) F_1 × *nanella* hyb. *sulfurea* (Shull 1923-b), neither the zygotic lethals of mut. *funifolia* nor the gametic lethal associated with sulfur flower color were considered, although the deficiency in the *nanella sulfurea* class might be explained as well by the presence of a pollen lethal as the deficient class in the preceding cross. In another cross involving revolute leaves and red stems, the zygotic lethals of mut. *funifolia* were not considered. It is possible that the *rubricalyx* plant used in the above cross did lack the zygotic lethals characteristically associated with this type, and the same may be true for the particular *funifolia* plant used, but no tests were made to determine the presence or absence of these lethals in either case.

CONCLUSIONS

In order to explain different crosses on the balanced lethal hypothesis, it has sometimes been necessary to assume that *O. lamarckiana* has both the zygotic lethals l_1 and l_2, and sometimes only one of them, apparently depending upon what cross it is in. Similarly, mut. *funifolia* must have had l_1 in some crosses and lacked it in others and mut. *rubricalyx* must at different times have carried only l_1, both l_1 and l_2, or neither. Likewise the pollen lethal as-

sociated with sulfur flower color must show crossing over with the sulfur factor or not depending upon what cross it is in. While it may be true that the zygotic lethals referred to are different in different individuals of the same type, no test has been made in any case to determine which lethals might be present, and their presence has been assumed in a cross only when it has been convenient to do so. In other cases they have been disregarded entirely. It is quite possible that there might be crossing over between the sulfur factor and the gametic lethal associated with it in some crosses and not in others if one assumes the presence of cross-over modifiers in one case —but these again have not been demonstrated.

As the experiments reviewed in this paper are the only ones thus far brought forth by Shull to prove the balanced lethal hypothesis for *Oenothera,* one must conclude that the discrepancies found demonstrate the failure of the data to support the particular form of the hypothesis that has been proposed.

It is not the purpose of this review to disprove the balanced lethal hypothesis for *Oenothera* nor to offer any alternative theory, but rather to show that the evidence thus far brought forward fails when critically examined to support this hypothesis. It is not impossible to make an adequate test of the hypothesis, but to do so one must test the genetic constitutions of the individual plants used.

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BOTANY.—*New plants from Central and South America.* S. F. Blake, Bureau of Plant Industry.

The new species here described, belonging to several families of Dicotyledones, have been found in the course of herbarium work during the past few years. In most cases the new species have been worked out in connection with the preparation of preliminary keys to the groups concerned.

Urtica granulosa Blake, sp. nov. Monoecious herb; stem densely incurved-puberulous, sparsely hispid; petioles slender; lower leaf blades broadly cordate-ovate, the middle and upper lanceolate, acuminate, coarsely toothed, incurved-pubescent, paler green but not canescent beneath; staminate spikes simple, about 3.5 cm. long; pistillate spikes mostly simple, 3 cm. long or less; pistillate perianth 1.8 mm. long, hispidulous, barely surpassing the ovate, whitish, granulose achene.

Stem simple, slender, probably tall, sulcate-quadrangular, densely but not canescently puberulous with incurved-ascending hairs and sparsely stimulose-hispid with spreading hairs; internodes (upper and middle) mostly 1.5–3.5 cm. long; leaves opposite; stipules linear-lanceolate, acute, puberulous, 6–8 mm. long; petioles 1–5.2 cm. long, pubescent like the stem; lower leaf blades 9.5 cm. long, 6.2 cm. wide, acute, coarsely and simply dentate (teeth about 19 pairs, deltoid, acute, about 5 mm. long), membranaceous, deep green; middle and upper leaves lanceolate, 6–11.5 cm. long, 2.5–4.5 cm. wide, often falcate, cuneate to truncate or subcordate at the often unequal base, coarsely toothed (teeth 12–21 pairs, sometimes with a lateral tooth, acute to obtuse, the terminal one elongate), above deep green, rather densely pubescent with mostly incurved hairs and sparsely hispid, beneath paler green, evenly and rather densely puberulous and sparsely hispid, 3 or 5-plinerved from near the base; axils (on upper part of plant) all floriferous, the staminate spikes below, densely flowered, 1.8–3.5 cm. long, the pistillate above, 0.5–3 cm. long, densely flowered, all hispidulous-puberulous and sparsely hispid; staminate calyx hispidulous, 1.8 mm. thick in bud; inner sepals of the pistillate calyx oval, obtuse; achene obtuse or acutish, marginate, 1.4 mm. long, 1 mm. wide.

Chihuahua: In shade of cliffs, canyon below Cusihuiriachic, September 21, 1888, *Pringle* 2005 (type no. 1,167,407, U. S. Nat. Herb.); Pilares, September 22, 1891, *C. V. Hartman* 748.

Distributed as *Urtica breweri* S. Wats., which has most of the leaves broadly ovate and sepals twice as long as the achene. In leaf outline and general appearance *U. granulosa* is similar to *U. aquatica* Liebm., but in that species the finer hairs of the stem are retrorse, and the pistillate calyx is glabrous. *Urtica mexicana* Blume (not Liebm.) and *U. serra* Blume are identical with *U.*

aquatica. Material of the type collections of all three species was examined by the writer some years ago in European herbaria.

Drymaria cognata Blake, sp. nov. Very slender dichotomous annual, glandular-hirtellous on the upper part of the internodes; leaves opposite, linear, acute, 3-nerved; pedicels glabrous or glandular-hirtellous; sepals lance-elliptic, acuminate, strongly 3-nerved, glabrous, about 4 mm. long; petals and capsule shorter than the sepals.

Densely dichotomous-branched from base, or rarely nearly simple in undeveloped specimens, about 14 cm. high; internodes of the main stem usually 2–4 cm. long; leaves 9–20 mm. long, 0.8–1.5 mm. wide, acute or acuminate, sessile, glabrous, prominulously 3-nerved beneath; stipules of the stem leaves scarious, linear-subulate, entire, 0.6 mm. long; leaves mostly wanting on the branches, replaced by lance-ovate, acuminate, scarious bracts 1.2–2 mm. long, with a green midnerve; flowers solitary in the forks and at apex of branchlets, the pedicels 0.5–2.8 mm. long; sepals 3.5–4.5 mm. long, with green 3-nerved center and subequal scarious margin, 2 somewhat shorter than the other 3; petals 5, white, 3.2 mm. long, linear-oblong, 2-lobed to below the middle; stamens 5, included; ovary subglobose, about 6-ovuled; style equaling ovary, longer than the 3 stigmatic branches; capsule ovoid, obtuse, 2–3 mm. long; seeds somewhat yellowish brown, densely blunt-muriculate, 0.8 mm. long.

DURANGO: City of Durango, April–November 1896, *Palmer* 912 (type no. 304403, U. S. Nat. Herb.)

SAN LUIS POTOSI: Near City of San Luis Potosi, 1879, *Schäffner* 542 in part.

Related to *Drymaria leptophylla* (Schlecht. & Cham.) Fenzl (including *D. gracillima* (Hemsl.) Rose, according to Briquet[1]), *D. effusa* A. Gray, and *D. nodosa* Engelm. In *D. nososa* the petals are longer than the sepals; in *D. effusa* the sepals are obtusish and slightly shorter than the petals; and in *D. leptophylla* the stem is glabrous and the sepals only 2–2.8 mm. long. *Palmer* 912, type of the new species, was listed by Rose under *D. gracillima* when the latter was raised to specific rank.

Drymaria peninsularis Blake, sp. nov. Many-stemmed annual, pale green or glaucescent, glandular-hirtellous throughout; leaves opposite, linear, the upper ones reduced to bracts; inflorescences elongate, racemiform; sepals obtuse, glandular-hirtellous, white-margined; seeds fuscous.

Root annual, apparently sometimes persisting and becoming perennial; stems evidently prostrate or ascending, up to 20 cm. long, branched; internodes mostly 1–2 cm. long; stipules scarious, subulate, entire, about 0.6 mm. long; leaves linear, fleshy, obtuse, 1-nerved, sessile, the lower and middle ones 1–2.5 cm. long, 0.8–1.5 mm. wide, the upper linear, 2–4 mm. long, much shorter than the pedicels; stems floriferous from about the middle, the pedicels solitary, axillary, in fruit 4–12 mm. long, erect to deflexed; sepals 5, oval-oblong, obtuse or rounded, green with broad white petaloid margins, obscurely 1 or 3-veined, 2.8–(fruit) 4 mm. long; petals 5, white, oblong-flabellate, contracted at base, 4–fid for nearly half their length (outer lobes oblong or obovate, blunt, the inner shorter and much narrower), 3 mm. long, about equaling the sepals, persistent, slightly exserted in fruit; stamens 5, included, the

[1] Ann. Cons. Jard. Genève **13-14**: 375. 1911.

filaments subulate, glabrous, alternating with as many glands and adnate to them at base; ovary globose; style about equaling the 3 stigmatic branches; capsule 3-valved, 3–4 mm. long, equaling the sepals; seeds bluntly muriculate, reniform, 0.9 mm. long.

BAJA CALIFORNIA: Cape region, January-March 1901, *Purpus* 423 (type no. 470422, U. S. Nat. Herb.); coast south of Pescadero, Nov. 1902, *Brandegee;* Cape San Lucas, *Xantus* 5, *Brandegee* 30, *Rose* 16357.

All these specimens have been identified as *Drymaria arenarioides* Willd. In that species, which occurs in Mexico from Chihuahua to Hidalgo, the leaves are shorter and somewhat broader (mostly elliptic or linear-elliptic), the upper ones are not conspicuously reduced, and the mature seeds are much lighter brown.

Bauhinia eucosma Blake, sp. nov. High-climbing vine, unarmed; branchlets appressed-pubescent; leaves bifoliolate, the leaflets semi-ovate, obtuse, pergamentaceous, glabrous and glaucescent above, sparsely appressed-pilose beneath chiefly along the nerves, 5-nerved; racemes pilose; pedicels about 1.5 cm. long; bractlets linear; calyx campanulate, 15-nerved, 2–2.5 cm. long, the teeth subulate, short; petals sericeous, 4 cm. long; perfect stamens 10; pod 10.5 cm. long, about 4-seeded.

Older branches gray-barked, glabrous, the younger brownish-gray; internodes about 1 cm. long or less; petioles slender, glabrous or sparsely hairy, 3 to 6 cm. long; leaves deeply and narrowly cordate, the basal sinus 1 to 2 cm. deep; leaflets 5.3 to 8.8 cm. long, 2.5 to 4.3 cm. wide, broadly rounded at base, erect, somewhat overlapping, deep green above, somewhat glaucescent, brownish beneath, rather coarsely prominulous-reticulate beneath, finely so above; racemes terminal, about 6 cm. long, 6 to 9-flowered, pilose with mostly appressed rufescent hairs; bracts deciduous; pedicels 11 to 16 mm. long, pubescent like the axis, bearing above the middle two linear bractlets about 3 mm. long; calyx thick-ovoid in bud, at maturity campanulate, 5-toothed (teeth pubescent, 2 to 3.5 mm. long), rufidulous-sericeous at base and on the nerves with appressed hairs, rufid-puberulous above between the nerves with appressed hairs; corolla "white;" petals inserted at base of calyx, obovate, densely rufescent-sericeous outside, the claw about 5 mm. long, the lamina rounded at apex, 1.2 to 1.5 cm. wide; stamens 10, all antheriferous, the filaments glabrous, 1.5 cm. long, the anthers hairy, 2.8 mm. long; ovary sessile, not adnate to the calyx, densely rufous-pilose, 6-ovulate, the stigma oblique; pod oblong-obovate, flat, apiculate, sessile, rufid-pilose with appressed hairs, 10.5 cm. long, 3.2 cm. wide.

PANAMA: Along river at the Agricultural Experiment Station, Matías Hernandez, Province of Panama, September 10, 1914, *Pittier* 7682 (type no. 716839, U. S. Nat. Herb.)

A member of the section *Tylotaea*, apparently near *Bauhinia hymeneaefolia* Triana, which, according to description, has coriaceous leaves, short-pedicelled flowers, ovate-oblong calyx lobes, and only 5 antheriferous stamens. According to Mr. Pittier's notes, the shrub is known as "bejuco de cadena," and the pounded stems yield a good fibre. The dry pods are used by children as windmills, and called "runrun."

Bauhinia obovata Blake, sp. nov. Vine?, unarmed; branchlets puberulous; leaves suborbicular-ovate in outline, bilobate for one-third their length,

9-nerved, thin-coriaceous, glabrous above, rufid-puberulous beneath; racemes dense, rufid-puberulous; bracts obovate, 4 mm. long; bractlets obovate or spatulate; calyx campanulate, about 11 mm. long, 13-nerved, the teeth obovate; petals pilose, 12 mm. long; perfect stamens 10.

Branches slender, angulate, the younger densely and finely rufid-puberulous, the older glabrescent; petioles puberulous, 1.5 to 3.5 cm. long; leaves 4 to 6.5 cm. long, 4 to 8 cm. wide, shallowly cordate at base, above rather pale green, somewhat shining, beneath brownish, densely and finely puberulous with appressed, shining, rufidulous hairs, the primary nerves prominent beneath and the secondaries prominulous, the lobes somewhat incurved, obtusely short-pointed; racemes short-peduncled, rather dense, 8.5 cm. long or less, sometimes with a basal branch, densely rufid-puberulous with mostly appressed hairs; bracts usually deciduous; pedicels mostly 6 to 9 mm. long, bearing above the middle 2 bractlets about 3 mm. long; calyx broadly campanulate, densely rufid-pubescent with appressed hairs, the tube 7 to 8 mm. long, the teeth 5, obovate or spatulate-obovate, obtuse, 3.5 mm. long, 1.5 to 2 mm. wide; petals obovate, rufous-pilose outside, venose, the claw about 4 mm. long, the lamina rounded, about 5 mm. wide; stamens 10, unequal, all antheriferous, the filaments glabrous, the anthers essentially so; ovary sessile, not adnate to the calyx, densely rufous-pilose, 4-ovulate, the stigma small, oblique.

PANAMA: Along the Sambú River, southern Darien, above tide limit, February 1912, *Pittier* 5568 (type no. 715834, U. S. Nat. Herb.)

A species of the section *Tylotaea*, apparently nearest the Brazilian *B. angulosa* Vogel, which is described as having small, narrow, very caducous bracts, small setaceous bractlet, and longer petals (half an inch longer than the calyx).

Stylosanthes linearis Blake, sp. nov. Herbaceous perennial, subsimple, hirsute below; sheaths of the stipules 1–1.6 cm. long, hispid-pilose; leaflets 3, linear, 1.8–3.5 cm. long, 1.5–2 mm. wide, acuminate, hirsute-ciliate; spikes many-flowered, collected in few, remote, subglobose heads about 1 cm. high and 1.5 cm. thick; axis rudiment present; bractlets 2; basal joint of pod minute; terminal joint oblong or oval-oblong, compressed, 4–4.2 mm. long, 2.8–3 mm. wide, 2-nerved and reticulate on each side, pilosulous, the incurved-uncinate beak 1.2–1.5 mm. long.

Several-stemmed; stems rather slender, simple or subsimple below the inflorescence, 60 cm. long, erectish, sparsely hirsute below with spreadingly slightly tuberculate-based yellowish-white hairs about 3 mm. long, glabrous above; middle internodes about 8 cm. long; sheaths of the stipules sparsely hispid-pilose like the stem and sometimes pilosulous when young, the teeth subulate, stiff, 4 mm. long; petioles pilosulous and rarely hirsute, 4 to 7 mm. long, the rachis about 1 mm. long; leaflets short-petiolulate, mucronate, rounded at base, firm, obscurely puberulous along midline above, usually sparsely hirsute-ciliate and sometimes with a few stiff hairs along the costa beneath, strongly 3-nerved to apex, the veins prominent beneath, the secondaries obscure; primary bracts unifoliolate, the sheath 3.5 to 4 mm. long, densely pilose-ciliate with whitish hairs, somewhat erect-pilose dorsally, the teeth 2 mm. long, the petiolulate blade linear-subulate, ciliate below, about 3 mm. long; secondary bract 1, linear-lanceolate, ciliate, entire, about 2.5 mm. long; axis rudiment slender-subulate, stiff, long-ciliate, 0.3 to 0.8 mm. long; bractlets 2, similar to the secondary bract but longer, about 3 mm. long;

calyx 6 mm. long (including the 2.8 mm. long, stipe-like base), the lobes ciliate; corolla yellow, the banner about 6 mm. long.

ARGENTINA: Common in "esteras," Las Palmas, Terr. Chaco, 1917, *P. Jörgensen* 2693 (type no. 1,065,486, U. S. Nat. Herb.)

A member of the section *Styposanthes*, nearest *Stylosanthes longiseta* M. Micheli, known to me only from description. In that plant the heads and the upper part of the stem are setose-hispid, the leaflets are oblong (1.2 to 1.4 cm. wide), and the scarcely reticulate fruit is nearly glabrous.

Caperonia angusta Blake, sp. nov. Stem sparsely hirsute-pilose, glabrate; leaf blades linear, acute, serrulate, nearly glabrous, the lateral veins about 8 pairs; flowers short-pedicelled; staminate flowers with 5 equal sepals, 5 subequal petals, and a 3-lobed ovary rudiment; pistillate flowers with 7 or 8 unequal sparsely glandular-ciliate sepals and 5 unequal petals; capsule muricate.

Herb 60 cm. high and more (the base not seen), much branched; stem slender, striatulate, pale green, very sparsely hirsute-pilose with mostly erect or ascending eglandular hairs; main internodes 2.5 to 5 cm. long; stipules ovate, acute, persistent, 1.5 mm. long; petioles sparsely strigillose, 1.5 to 3 mm. long; blades 2.5 to 5.5 cm. long 3 to 5 mm. wide, rounded at base, serrulate with about 8 pairs of small, acute, remote teeth, rather pale green, glabrous above, beneath sparsely strigose on costa and veins or nearly glabrous, featherveined, the lateral veins about 8 pairs, straight, prominulous beneath, the secondaries barely prominulous; peduncles axillary, 5 to 15 mm. long, somewhat hirsute with erect or divergent hairs; racemes 0.8 to 2 cm. long, the lowest flower pistillate, remote from the 8 to 20 staminate flowers; bracts ovate, acute, persistent, 1 mm. long or less; pedicels of the staminate flowers about 0.5 mm. long; sepals 5, equal, ovate, acute, glabrous, 1.5 mm. long; petals 5, subequal, oblong or elliptic-obovate, rounded at apex, 1.2 mm. long; stamens 10, the anther cells subpendulous from the thickened gland-like connective; ovary rudiment distinctly 3-lobed; pedicel of the pistillate flower about 1 mm. long; sepals 7 or 8, unequal, the 3 or 4 largest ovate, acute, 2 to (fruit) 2.8 mm. long, bearing one or two long gland-tipped hairs on each margin and sometimes on the back, the 2 or 3 smallest lanceolate or lance-ovate, about 1 mm. long, the others intermediate in size and shape; petals 5, unequal, white, 1 larger, spatulate-obovate, acute, 3 mm. long, 1.2 mm. wide, the other 4 narrowly oblanceolate, 3 mm. long, 0.8 mm. wide, or sometimes all subequal, oblanceolate-obovate, 3 mm. long, short-pointed; ovary muricate; styles 5 or 6-fid for about three-fourths their length; capsule subglobose, about 3 mm. high, 4 mm. thick, muricate on the upper half, the projections ending in usually gland-tipped hairs.

PANAMA: In a spot subject to inundation, Agricultural Experiment Station, Matías Hernandez, Province of Panama, January 1–15, 1915, *Pittier* 6927 (type no. 716988, U. S. Nat. Herb.)

A member of the section *Eucaperonia*, nearest *C. panamensis* Pax & K. Hoffm., from which it differs in the more numerous sepals of the pistillate flower (5 in *C. panamensis*), these provided with a few gland-tipped cilia, the 3-lobed ovary rudiment, and other features. As the name *C. panamensis* has been used previously by Klotzsch,[2] the species described as new by Pax and K. Hoffmann[3] under this name may be renamed **C. stenomeres.**

[2] In Seem. Bot. Voy. Herald 103. 1852–57.

[3] In Engl. Pflanzenreich, Teil 4, **147**^{7}: 424. 1914.

Meliosma idiopoda Blake, sp. nov. Shrub or tree; branches obscurely strigillose, glabrate; petioles short-strigose, about 8 mm. long; leaf blades elliptic or obovate, acuminate at each end, chartaceous, wavy-margined but entire, essentially glabrous, about 18 cm. long; panicles subcylindric or conical, puberulous, 13–21 cm. long, 3.5–8 cm. wide; pedicels 1–1.5 mm. long; sepals somewhat unequal; petals unequal; disk nearly half as long as ovary, bearing several marginal glands.

Branches slender; leaves alternate; petioles naked, slender, 4–10 mm. long; blades falcate-acuminate, long-acuminate to the acute base, 14.5–21 cm. long, 3.8–6.5 cm. wide, obscurely strigillose along costa, densely whitish-papillose beneath, featherveined, the costa and the 8–10 pairs of lateral veins impressed or flattish above, prominent beneath, the loosely reticulate veinlets finely prominulous on both sides; panicles solitary in the axils toward apex of branches, rufid-puberulous with suberect hairs, the peduncle about 3.5 cm. long, the axis 10 to 17 cm. long, the lower branches sometimes 6.5 cm. long and much longer than the other branches, sometimes only 1.5 cm.; sepals 5, the 2 outermost oval-ovate or suborbicular-ovate, acutish to obtuse, glandular-ciliolate, otherwise glabrous, the 3 inner somewhat larger, suborbicular, rounded, glandular-ciliolate, 1.5 mm. long and wide; petals 5, unequal, 2 of the outer suborbicular, obscurely ciliolate-erose, otherwise glabrous, about 1.3 mm. long, 1.8 mm. wide, the other outer one as long but 2.5–2.8 mm. wide, the 2 inner (opposite the perfect stamens and adnate to their filaments at base) cuneate-oblong, 0.8 mm. long, broadly bifid, the teeth ciliolate; stamens 5, 3 sterile (the one adnate to the broadest petal with 2 large empty cells, the 2 adnate to the 2 other broad petals with 1 large empty cell), 2 fertile and with longitudinally dehiscent anthers; disk closely girdling ovary, bearing about 5 glandular teeth; ovary sparsely pubescent at apex, 2-celled, the cells 2-ovuled, the ovules superposed; style glabrous, entire, slightly shorter than ovary; stigmas connate.

COSTA RICA: Forests of Las Vueltas, Tucurrique, altitude 635–700 meters, May 1899, *Tonduz* 13372 (type no. 861231, U. S. Nat. Herb.)

Related to *Meliosma glabrata* (Liebm.) Urban and *M. tonduzii* Donn. Smith, both Costa Rican. Both species, according to description, are at once distinguished from *M. idiopoda* by having the style about twice as long as the ovary, in addition to various other differences.

Hypericum galinum Blake, nom. nov.

Hypericum denticulatum H. B. K. Nov. Gen. & Sp. 5: 191. *pl. 458.* 1821. Not *H. denticulatum* Walt. 1788.

Hypericum denticulatum Walt. (Fl. Carol. 190. 1788) is the tenable name[4] for the plant usually known as *H. virgatum* Lam., and the homonymous Mexican species must consequently be renamed.

Vaccinium dasygynum Blake, sp. nov. Low shrub, very leafy; branches densely griseous-pilosulous with mostly spreading hairs; leaves petioled, ovate to ovate-elliptic, 9–15 mm. long, crenate-serrulate, coriaceous, obscurely pubescent; racemes short, in the uppermost axils; flowers 4 or 5-merous; calyx tube densely pubescent, the teeth nearly glabrous; corolla campanulate-urceolate, 5.5 mm. long, glabrous; stamens 8 or 10, the filaments ciliate and pilose; anthers exaristate; tubules $1\frac{1}{2}$ times as long as the sacs; young fruit densely pilose.

[4] Blake, Rhodora 17: 134. 1915.

Apparently erect; petioles pilosulous, about 2 mm. long; blades 3–10 mm. wide, obtuse or acutish, cuneate to rounded at base, marginate but not revolute, crenate-serrulate from near the base with 6–14 pairs of blunt, gland-tipped teeth, above dull green, puberulous along costa and when young sometimes on surface, beneath brownish, sparsely hirsutulous with dark hairs leaving little pits in falling, ciliolate toward base, the lateral veins about 3 pairs, impressed above and bluntly prominulous beneath or nearly obsolete on both surfaces; racemes several in the upper axils, about 7-flowered, the axis about 8 mm. long, pilosulous, the bracts suborbicular-ovate, obtuse, ciliolate, otherwise essentially glabrous, reddish, about 3 mm. long, deciduous; pedicels pilosulous, 2–4 mm. long, bearing 1–2 deciduous bractlets near base; calyx tube campanulate, 2.5 mm. long, densely griseous-pilosulous with spreading or ascending hairs, the limb 2 mm. long, the 4–5 teeth suborbicular-deltoid (1.2 mm. long), obtuse or acute, sparsely glandular-denticulate, reddish, nearly or quite glabrous; corolla (pink?) 4 mm. thick, the 4–5 deltoid, obtuse, recurved-spreading teeth 1 mm. long; stamens all alike and equal, 4.8 mm. long, the filaments distinct, ciliate, pilose within, sparsely so outside, 2.5 mm. long, the anther sacs finely muriculate, 1.2 mm. long, the 2 tubules distinct, cylindric, opening by terminal pores, 1.7 mm. long; ovary 4 or 5-celled, the cells without false partitions, the ovules numerous; style glabrous, barely exserted.

ECUADOR: Vicinity of Nabón, September 25, 1918, *J. N. Rose, A. Pachano, & G. Rose* 23017 in part (type no. 1,189,978, U. S. Nat. Herb.); vicinity of Tablón de Ona, September 27, 1918, *Rose, Pachano & Rose* 23082 in part.

Closely allied to *Vaccinium floribundum* H. B. K., in which the calyx is nearly or quite glabrous. *V. dasygynum* may prove to be only a form of that species, but seems distinct on the basis of the specimens examined. The specimens were mixed in one case with *Gaultheria reticulata* H. B. K., and in the other with *Vaccinium floribundum*.

Vaccinium retifolium Blake, sp. nov. Prostrate or reclining shrub, very leafy; stem and branches densely spreading-hirtellous; leaves short-petioled, elliptic, about 9 mm. long, acutish at each end, bluntly crenate-serrulate, veiny; flowers solitary, axillary, on pedicels 4–7 mm. long; calyx glabrous, 5-toothed; corolla broadly campanulate, 5-toothed, 7.5 mm. long and thick, glabrous throughout; stamens 12(?), all alike and equal, unappendaged; filaments distinct, hairy; anther sacs slightly longer than the tubules.

Stem branched, about 35 cm. long, rather slender; petioles 1–2 mm. long, densely hirtellous like the base of the costa; blades 7–11 mm. long, 3–4.5 mm. wide, short-ciliate toward base, otherwise glabrous, crenate-serrulate above the usually entire lower third with 3–8 pairs of obtuse, gland-tipped teeth, coriaceous, not revolute on margin, green and somewhat shining above, usually brownish or reddish beneath, feather-veined, the veins 4–5 pairs, anastomosing and usually forked toward apex, prominulous or impressed above, bluntly prominulous beneath; flowers few, solitary in the axils toward apex of stem; pedicels glabrous, somewhat thickened toward apex, bearing 2–5 ovate, acute or acuminate, coriaceous, glabrous bractlets about 1 mm. long; calyx 4 mm. long, the tube subglobose, 2 mm. long, equaling the limb, the teeth deltoid, acuminate, 1.5 mm. long, sometimes with a small glandular tooth on one side near middle; corolla thickish, the teeth slightly spreading at apex, suborbicular-deltoid, obtusish, 2 mm. long; stamens 4 mm. long,

the filaments lanceolate, 2.2 mm. long, densely hirsutulous dorsally and on margin, nearly glabrous inside, the anther sacs finely muriculate, 12 mm. long, the tubules distinct, cylindric, 1 mm. long; ovary 5-celled; style glabrous, 5 mm. long; berry globose, about 6 mm. thick, the seeds numerous in each cell.

ECUADOR: Vicinity of Portovelo, October 6–15, 1918, *J. N. Rose & G. Rose* 23387 (type no. 1,002,890, U. S. Nat. Herb.); Nabón, Sept. 25, 1918, *Rose, Pachano, & Rose* 22989.

A member of the section *Neurodesia*, allied to *Vaccinium reclinatum* Niedenzu (*V. reflexum* Hook. f., not Klotzsch) and much resembling the plate of that species, but with solitary flowers, longer corolla, and tubules nearly as long as the anther sacs. The single corolla examined had 11 stamens, with a space for a twelfth.

Macleania euryphylla Blake, sp. nov. Leafy shrub; stem cinereous-pilosulous with curved mostly spreading hairs; petioles stout, about 5 mm. long; leaf blades broadly ovate, broadly rounded at apex, broadly rounded or slightly cordate at base, about 6 cm. long; racemes fasciculiform, the axis glabrous; calyx glabrous, about 6 mm. long; corolla glabrous throughout, 1.4 cm. long; filaments ciliate; tubules of the anthers 2, connate, equaling the sacs.

Stem stout, sulcate, glabrescent on the rounded angles; internodes about 2 cm. long; petioles curved-pilosulous, 4–7 mm. long; blades 4.3 to 6.3 cm. long, 2.5–5 cm. wide, strongly coriaceous, sparsely ciliolate at base or glabrous, sparsely impressed-punctate especially above, light green above, brownish beneath, not revolute on margin, featherveined (chief lateral veins 3 pairs) and loosely prominulous-reticulate beneath, the chief veins impressed above; racemes axillary, many-flowered, the axis stout, glabrous, about 5 mm. long, the bracts suborbicular, about 3 mm. long, ciliolate, nearly or quite glabrous dorsally; pedicels stout, glabrous, about 7 mm. long, jointed at apex, bearing 2 roundish ciliolate bractlets near base; calyx campanulate, 6–7 mm. long, about 6 mm. wide, the 5 acute teeth about 1 mm. high; corolla ovoid-tubular, fleshy, probably red, 5 mm. thick below, the 5 teeth ovate, obtuse or acutish, erectish, 1.5 mm. long; stamens 10, all alike, 8.5 mm. long, the filaments distinct, flat, pilose-ciliate especially above and sparsely pilose in front and back, 2.8 mm. long, the anther sacs oblong, strongly muriculate, 3.8–4 mm. long, the tubules connate to apex, 3.8–4 mm. long, opening by elongate slits; ovary 5-celled; style glabrous, 1.8 cm. long, exserted about 4 mm.

ECUADOR: Cusatagua, near Ambato, Prov. Tunguragua, March 1919, *A. Pachano* 179 (type no. 1,033,456, U. S. Nat. Herb.).

This species enters Horold's[5] group II, A of *Macleania*. It is distinguished from most species of that group by its broadly ovate, round-tipped leaves, and from the others by characters of pubescence or dimensions. In leaves and inflorescence it is very similar to the figure of *M. cordata* Lem. (Fl. des Serres I. 4: 312. 1848), but that species is at once distinguished by having the corolla teeth pubescent inside. The vernacular name is given by the collector as "sagalita."

[5] Bot. Jahrb. Engler 42: 269. 1909.

Forsteronia amblybasis Blake, sp. nov. Shrub or tree; branches and branchlets glabrous; leaves opposite; petioles 7–11 mm. long; leaf blades oval or elliptic-ovate, about 12 cm. long, short-pointed or subacuminate, rounded at base, glabrous except in the axils of the veins, pergamentaceous, the chief lateral veins 4–6 pairs; panicles puberulous, slender, the primary branches short, the flowers glomerate, subsessile; calyx eglandular, the sepals oblong, obtuse, 2 mm. long, finely ciliolate; corolla 3.5 mm. long, the lobes ovate-oblong, 2.2 mm. long, sparsely puberulous outside, densely pilose-barbate inside especially toward apex.

Branches and branchlets (the latter dull brown) conspicuously lenticellate; petioles slender, naked, glabrous or slightly puberulous; blades 9.5–13 cm. long, 3.5–6 cm. wide, mucronulate at the obtuse or acute apex, usually broadly rounded at base, dull or somewhat shining green above, brownish green especially along the nerves beneath, the costa and chief lateral veins impressed above, prominent beneath and with incomplete barbatulate cups in the axils, the veinlets prominulous above, scarcely so beneath; panicles terminal and in the upper axils, densely spreading-puberulous when young, sparsely so when old, the peduncle 1.4–4.5 cm. long, the axis 7–19 cm. long, the branches few, subopposite, 4.5 cm. long or less, the flowers collected in glomerules toward their tips, and at apex of panicle interrupted-glomerate, the glomerules 7–10 mm. thick; bracts oblong, about 3.5 mm. long, apiculate, ciliolate, otherwise nearly glabrous; pedicels puberulous, about 1.3 mm. long or less; sepals oblong or ovate-oblong, 2–2.2 mm. long, obtuse or acute, finely puberulous on middle of back or essentially glabrous except for the ciliolate margin; corolla campanulate, the 5 lobes suberect, the tube 1.3 mm. long, densely annulate-barbate inside near middle, the lobes obtuse; stamens 1.8 mm. long, the filaments about half as long as the anthers, the anthers glabrous outside, their tails thickened, truncate; nectary 5-lobed; ovaries hispidulous at apex.

BOLIVIA: Tipuani to Guanai, December 1892, *M. Bang* 1689 (type no. 1,167,408, U. S. Nat. Herb.); Polo-Polo near Coroico, North Yungas, altitude 1100 m., October-November 1912, *O. Buchtien* 3953.

Both these collections were distributed as *Forsteronia sellowii* Muell. Arg., to which species *F. amblybasis* seems to be nearest. In that South Brazilian plant, however, according to Mueller's description, the leaves are subacute at base and considerably smaller, the panicle is glabrous, the calyx and corolla are somewhat smaller, the corolla is fulvo-puberulous outside, its lobes are merely hispidulous inside, and the anthers are hispidulous on the back above.

Fischeria boliviana Blake, sp. nov. Vine, densely and finely glandular-hirtellous and rather densely spreading-hirsute; leaf blades oval-obovate, short-pointed, narrowly cordate at base, densely and finely pilosulous on both sides; peduncles mostly exceeding the leaves; flowers numerous, 1.8 cm. wide; sepals lanceolate, acuminate, puberulous and hirsute, about $\frac{3}{4}$ as long as the corolla; corolla lobes oblong-ovate, obtuse or acutish, pubescent on both sides, not distinctly ciliate, crisped on one side.

Stem and branches rather stout; leaves opposite; petioles pubescent like the stem, 1.5–2.2 cm. long; blades (only the upper seen) 5–6.5 cm. long, 3–3.8 cm. wide, abruptly short-pointed (the point about 2 mm. long), narrowly cordate at base (the sinus usually open, about 4 mm. deep), papery, above light green, densely and softly spreading-pilosulous (the hairs with barely enlarged base), beneath brownish green, similarly pubescent with shorter

hairs and along the veins sparsely hirsute, hirsute on margin, feather-veined, the lateral veins about 6 pairs; peduncles solitary, axillary, pubescent like the stem, 3–6 cm. long; inflorescences umbelliform or shortly racemose, similarly pubescent; pedicels 1.1–1.6 cm. long; buds apiculate; sepals 7 mm. long, 1.5–2 mm. wide below, reflexed; calycine glands small, easily deciduous; corolla deeply 5-parted, the lobes hispidulous-puberulous outside, hirsute-pilose inside except along the sulcate-plicate glabrous midline, 8 mm. long, 4.5 mm. wide; outer corona fleshy, adnate to base of corolla and to gynostegium, about $\frac{2}{3}$ as long as the latter; inner corona of 5 fleshy, oval, rounded lobes equaling the gynostegium, their inner margins prolonged into deltoid obtuse lobes applied to the apex of the disk of the gynostegium.

BOLIVIA: Beni River, July 1886, *Rusby* 936 (type no. 32499, U. S. Nat. Herb.)

Related to *Fischeria calycina* Decaisne, which is described as with peduncles equaling the leaves, and lanceolate attenuate merely puberulous corolla lobes; also related to *F. peruviana* Decaisne, which is said to have only a few scattered hairs on the inner surface of the corolla lobes, while those of *F. boliviana* are rather densely hirsute-pilose inside.

Fischeria funebris (Donn. Smith.) Blake.

Fischeria martiana var. *funebris* Donn. Smith, Bot. Gaz. **24:** 398. 1897.

Stem densely and minutely subglandular-puberulous and less densely spreading-hirsute; petioles similarly pubescent; leaf blades oval-ovate to obovate, usually rather long-acuminate, cordate at base, papery, densely hirsute-pilose or hirsutulous above (the hairs longer along the costa), beneath brownish, densely and rather softly hirsute-pilose or pilosulous (the hairs longer along the veins); peduncles longer than the leaves; inflorescences umbelliform, becoming short-racemose; pedicels 2–3.5 cm. long; buds very obtuse; sepals narrowly lance-subulate, attenuate, 9–15 mm. long, distinctly exceeding the corolla, puberulous and hirsute; calycine glands present; corolla about 1.8 cm. wide, deeply 5-lobed, fleshy, the lobes ovate, obtuse, strongly plicate-crisped on one side, somewhat crisped toward apex on the other side, not sulcate-plicate along midline except at extreme base, hirsutulous on both surfaces except toward margin and apex; outer corona fleshy, subentire, about half as long as gynostegium; inner corona of 5 fleshy, obtuse lobes surpassing the gynostegium, their inner margins prolonged into suborbicular appressed lobes.

GUATEMALA: Between Sepacuité and Secanquim, Alta Verapaz, altitude 400 m., May 18, 1905, *Pittier* 311.

COSTA RICA: Hacienda Veyta, Río Volcán, Valley of Diguis, Feb. 12, 1898, *Pittier* 12065; Las Vueltas, Tucurrique, altitude 600–700 m., Jan. 1899, *Pittier* 13182; Finca de Chirripò, plains of Zent, altitude 200 m., Feb. 1900, *Pittier* 16054; Río Honda, altitude 50 m., Feb. 15, 1903, *Pittier*, 16641.

This plant is clearly a distinct species from the Brazilian *Fischeria martiana* Decaisne, which is described as having larger flowers, sepals equaling the corolla, acute buds, and a white corolla veined with green, its lobes sulcate-plicate along the midline. In *F. funebris* the corolla appears to be densely veined with dark on a light ground.

ORNITHOLOGY.—*Descriptions of new Treronidae and other non-passerine birds from the East Indies.* HARRY C. OBERHOLSER, Biological Survey.

Further evidence of the richness and value of Dr. W. L. Abbott's East Indian bird collections for the United States National Museum is furnished by the following new birds. The names of colors used in these descriptions are from Ridgway's *Color standards and color nomenclature.*

ARDEIDAE

Butorides javanicus carcinophonus, subsp. nov.

Subspecific characters.—Similar to *Butorides javanicus javanicus*, from Java, but larger, and somewhat lighter on neck and under surface.

Description.—Type, adult female, no. 182229, U. S. Nat. Mus.; Pulo Alanga, eastern Borneo, May 12, 1913; Dr. W. L. Abbott. Forehead greenish slate; pileum and crest deep slate green, the tip of the crest more slaty; the middle of the crown dark ivy green, slightly metallic; cervix mouse gray; upper back brownish neutral gray; remainder of back and its plumes light grayish olive, the edges and tips of the feathers glaucous; rump and upper tail-coverts deep mouse gray; tail deep slate olive, somewhat metallic; wings slate color, the exposed outer parts of the webs of the feathers dark ivy green; anterior lesser coverts more brownish and duller, the edgings buffy white, cinnamon buff, and sayal brown; middle of the chin mostly creamy white; sides of chin and of neck, together with the throat and jugulum, rather brownish mouse gray, the middle of the lower jugulum paler; breast, sides, flanks, and crissum, neutral gray, the breast washed with brownish; abdomen pale grayish buff; lining of wing light neutral gray.

Measurements of type.—Wing, 168.5 mm.; tail 63; exposed culmen, 64; height of bill at base, 12; tarsus, 45; middle toe without claw, 40.5.

Butorides javanicus carcinophilus, subsp. nov.

Subspecific characters.—Similar to *Butorides javanicus carcinophonus*, from Borneo, but lower parts paler.

Type.—Adult female, no. 201671, U. S. Nat. Mus.; Casiguran, Luzon Island, Philippine Islands, June 1, 1907; Dr. E. A. Mearns; original number, 15262.

Measurements of type.—Wing, 161 mm.; tail, 57; exposed culmen, 62; height of bill at base, 12.5; tarsus, 44; middle toe without claw, 41.

MEGAPODIIDAE

Megapodius forsteni balukensis, subsp. nov.

Subspecific characters.—Similar to *Megapodius forsteni forsteni*, of the Molucca Islands, but having the upper surface darker and more rufescent, the cervix more or less overlaid with brown; lower parts darker; and size slightly smaller.

Description.—Type, adult female, no. 200692, U. S. Nat. Mus., Baluk, Baluk Island, Sulu Sea, Philippine Islands, January 10, 1906; Dr. E. A. Mearns. Pileum dull olive brown; upper cervix deep mouse gray, slightly washed with olive brown; lower cervix, together with the rump, back, and

scapulars, dark prouts brown; upper tail-coverts and tail, clove brown; wings rather rufescent clove brown, the edgings of tertials, of inner greater and middle coverts, like the back, the lesser coverts and remaining portion of the other coverts, chaetura drab; sides of head, together with chin and upper throat, mouse gray; sides of neck, together with remaining lower parts and lining of wing, deep mouse gray, the abdomen washed with olive brown.

Measurements of type.—Wing, 211 mm.; tail, 73.5; exposed culmen, 22.5; height of bill at base,; 10; tarsus, 61.5; middle toe without claw, 40.

This island race is apparently still more different from *Megapodius forsteni cumingii* of the island of Palawan, in the Philippine Archipelago, being very much darker both above and below.

RALLIDAE

Hypotaenidia striata paraterma, subsp. nov.

Subspecific characters.—Similar to *Hypotaenidia striata striata,* from the Philippine Islands,[1] but much darker above, the ground color more extensively and deeply blackish, the edgings also more deeply colored, and the white spots on hind neck, back, and rump much fewer and smaller; lower parts somewhat darker; and white bars on flanks and sides much narrower and farther apart.

Description.—Type, adult female, no. 161078, U. S. Nat. Mus.; Samar Island, Philippine Islands, April 18, 1888; F. S. Bourns. Pileum and upper cervix, bay, somewhat blackish medially; remaining upper parts brownish black barred with white, the edgings of the feathers varying from saccardo umber to sepia; chin creamy white; sides of head and the greater part of the sides of the neck, together with the throat and breast, between neutral gray and mouse gray, the breast washed with olive brown; primaries and secondaries between fuscous black and fuscous; the rest of the wings and the remaining portion of the under surface colored like the back; lining of wing brownish black, barred with white.

Measurements of type.—Wing, 114, mm.; tail, 45; exposed culmen; 38; tarsus, 34; middle toe without claw, 37.

This new race is of interest since it differs apparently so much from the typical form of the species, which inhabits the other islands of the Philippine Archipelago,—Luzon, Siquijor, Panay, and others. It is, in fact, as dark as *Hypotaenidia striata obscurior* Hume, of the Andaman Islands, but is distinguishable by smaller size; by rather broader more widely spaced white bars on sides and flanks; and by larger white spots and wider white bars on the upper parts.

The original *Hypotaenidia striata striata*[2] came from the Philippine Islands, but had no more definite locality assigned. Since it is desirable now to have an exact type locality, we will designate this as Manila, on the island of Luzon, from which the original specimen probably came.

[1] Type locality: Manila, Island of Luzon, Philippine Islands.

[2] [*Rallus*] *striatus* Linnaeus, Syst. Nat., ed. 12, 1: 262. 1766 (after May 24). "Philippinis".

TRERONIDAE

Muscadivores aeneus arhadius, subsp. nov.

Subspecific characters.—Similar to *Muscadivores aeneus aeneus*, from Borneo, but with tail more greenish; cervix, top and sides of head averaging more grayish.

Description.—Type, adult female, no. 180106, U. S. Nat. Mus.; Kateman River, eastern Sumatra, September 3, 1903; Dr. W. L. Abbott. Top and sides of head, light grayish vinaceous, the crown overlaid with gull gray; cervix gull gray; chin, extreme anterior part of forehead, and orbital ring, creamy white; remaining upper parts metallic bluish green with a strong bronzy sheen; tail bluish green with a slight metallic gloss, the middle pair of rectrices most decidedly blue; tertials metallic green like the back; primaries and secondaries, fuscous on the basal two-thirds of inner half of inner webs, glaucous greenish slate color on the remaining portion, the outer vanes of the secondaries with more or less metallic green gloss; primary coverts and exterior greater coverts greenish slate, with some metallic green on their outer webs; rest of upper wing-coverts metallic green like the back; throat pale grayish vinaceous; jugulum gull gray; breast and abdomen, light grayish vinaceous; sides of the same shade, but overlaid and tinged with gull gray; flanks gull gray; crissum dark bay; lining of wings between gull gray and deep gull gray.

Measurements of type.—Wing, 228 mm.; tail, 140; exposed culmen, 23.5; tarsus, 31; middle toe without claw, 37.

Haemataena melanocephala enantia, subsp. nov.

Subspecific characters.—Similar to *Haemataena*[3] *melanocephala bangueyensis*, from Mindanao, but with yellow of throat darker; yellow of middle of lower abdomen paler, showing thus more contrast to the crissum.

Description.—Type, adult male, no. 191872, U. S. Nat. Mus.; Cagayan Sulu Island, Philippine Islands, February 26, 1904; Dr. E. A. Mearns. Head and throat, pale gull gray, but the forehead, sides of head, sides of throat, and the middle of the lower throat, between light gull gray and pallid neutral gray, with a large black patch on the occiput; chin and upper throat, between light cadmium and lemon chrome; cervix and sides of neck, warbler green, shading a little to citrine on the upper back and scapulars; lower back, rump, and upper tail-coverts, cerro green; tail-feathers basally and, excepting the middle pair, also on marginal portion of inner webs, fuscous, the remaining portion of the feathers somewhat metallic green, between scheele's green and grass green, some of the feathers bronzy, and having on the two middle rectrices numerous narrow, almost invisible, bronzy bars; wings fuscous, the superior coverts and the exposed portion of the quills (except the secondaries) in the closed wing somewhat metallic olive green, cerro green, bronzy green, and dark green, all mingled together, the general effect being nearly olive green; secondaries between scheele's green and grass green; jugulum and breast, between cerro green and spinach green, and shading to between parrot green and grass green on abdomen, sides, and thighs; lower abdomen empire yellow, verging slightly toward apricot yellow; crissum chrome yellow to cadmium yellow, the longest middle lower tail-coverts mostly rose red; lining of wing neutral gray, outwardly mostly cerro green.

[3] For the use of this generic name instead of *Spilotreron* Salvatori, *cf.* Richmond, Proc. U. S. Nat. Mus. **53**: 593. 1917.

Measurements of type.—Wing, 119 mm.; tail, 77; exposed culmen; 55.5; tarsus, 22; middle toe without claw, 22.5.

This new race is apparently confined to the island of Cagayan Sulu.[4]

Treron curvirostra erimacra, subsp. nov.

Subspecific characters.—Resembling *Treron curvirostra nasica*, from Borneo, but much larger, and, in the male, of lighter coloration.

Description.—Type, adult male, no. 201778, U. S. Nat. Mus.; Balabac Island, Philippine Islands, October 16, 1906; Dr. E. A. Mearns. Pileum slate gray, lightening to rather dark gull gray on the forehead; cervix between deep grape green and pois green; cervical collar deep gull gray; middle of back purple drab; remainder of back, together with the scapulars, dull, dark corinthian purple; rump olive green; upper tail-coverts warbler green; middle tail-feathers dark citrine; basal portion of the remaining tail-feathers slate gray, the subterminal portion black, the tip dark gull gray; wings black, slightly brownish; but the tertials olive green, the bend of the wing slate gray, slightly washed with olive, the lower rows of lesser coverts andover green, the edgings of the wings lemon yellow; sides of neck and of face like the cervix; chin and throat, lime green; jugulum yellowish citrine; breast grape green; abdomen grape green shading to asphodel green, darker laterally, and passing into slate gray on the sides of the body; flanks and thighs, calla green mixed with creamy white; lower tail-coverts between sayal brown and ochraceous tawny; lining of wing slate gray.

Measurements of type.—Wing, 137 mm.; tail, 88.5; exposed culmen, 17; height of bill at base, 7.5; tarsus, 22; middle toe without claw, 23.

This is the bird that has been commonly recorded from the Philippine Islands as *Treron nipalensis*, but it is readily distinguishable from the bird from Borneo, which is clearly a subspecies of *Treron curvirostra*, as well as from the typical race of the Malay Peninsula.[5] From the latter it differs in both sexes in its darker coloration, particularly on the upper parts.

Dendrophassa vernans nesophasma, subsp. nov.

Subspecific characters.—Similar to *Dendrophassa vernans vernans*, from Luzon Island, Philippine Islands, but in both sexes paler throughout and with the green of upper parts averaging more grayish.

Description.—Type, adult male, no. 191947, U. S. Nat. Mus.; Cottabata, Mindanao Island, Philippine Islands, March 3, 1904; Dr. E. A. Mearns. Pileum between hathi gray and cinereous; forehead dark pearl gray; cervix between pale and light vinaceous drab, washed with plumbeous medially; interscapulum and rump, deep grape green, the scapulars between courge green and light hellebore green; upper tail-coverts isabella color, gradually verging into the grape green of rump; tail slate gray, with a broad subterminal band of black, and tipped narrowly with slate black; wing-quills, except the tertials, slate black, the outer primaries brownish black distally, all the quills

[4] For a list of the other subspecies of *Haemataena melanocephala*, *cf.* Oberholser, Proc. U. S. Nat Mus. **54**: 192. 1917.

[5] For the change of specific name from *Treron nipalensis* to *Ireron curvirostra* (Gmelin), *cf.* Oberholser, Smithson. Misc. Coll. **60**: no. 7: 3, footnote. 1912. The type locality of *Columba curvirostra* Gmelin is there designated as "Malay Peninsula"; we here further restrict it to the *town* of Malacca.

shading inwardly into slate gray basally; tertials and superior wing-coverts, between courge green and light hellebore green, the bend of wing washed with plumbeous, the greater coverts and tertials conspicuously margined distally on their outer webs with picric yellow; chin, throat, and sides of head, between dawn gray and pearl gray; jugulum like the cervix, but not washed with plumbeous; middle of breast between ochraceous orange and yellow ochre; lower breast and upper abdomen, lime green, darker and duller laterally, sides deep gull gray; lower abdomen pinard yellow; flanks partly lincoln green, partly deep grape green, broadly streaked with pinard yellow; crissum rather light auburn; lining of wing deep gull gray.

Measurements of type.—Wing, 148 mm.; tail, 92; exposed culmen, 17; tarsus, 22; middle toe without claw, 23.

In addition to Mindanao, this race occupies at least the islands of Basilan, Jolo, and Sulu.

Dendrophassa vernans abbotti,[6] subsp. nov.

Subspecific characters.—Resembling *Dendrophassa vernans vernans*, from Luzon Island, Philippine Islands, but in the male darker and duller above; in the female darker, duller, less greenish above, duller, less greenish or less yellowish below, the abdomen usually paler, and medially often even whitish.

Type.—Adult male, no. 153653, U. S. Nat. Mus.; Tyching; Trang, Lower Siam (Malay Peninsula), June 2, 1896; Dr. W. L. Abbott.

Measurements of type.—Wing, 140.5 mm.; tail, 90; exposed culmen, 15.5; tarsus, 22; middle toe without claw, 24.5.

This subspecies ranges apparently over all the Malay region, from Singapore to Siam.

Dendrophassa vernans zalepta, subsp. nov.

Subspecific characters.—Similar to *Dendrophassa vernans vernans* of Luzon Island, Philippine Islands, but decidedly smaller.

Type.—Adult male, no. 248190, U. S. Nat. Mus.; Kwala Besar, Celebes, August 24, 1914; H. C. Raven; original number, 1538.

Measurements of type.—Wing, 137 mm.; tail, 81; exposed culmen, 16.5; tarsus, 20.5; middle toe without claw, 23.5.

This new form is distinguishable from *Dendrophassa vernans nesophasma*, of the southern Philippine Islands, by reason of much smaller size, and somewhat darker coloration. It appears to be confined to the island of Celebes.

Dendrophassa olax arismicra, subsp. nov.

Subspecific characters.—Similar to *Dendrophassa olax olax*, from Sumatra, but much smaller; and upper parts darker, particularly the rump and pileum.

Description.—Type, adult male, no. 181777, U. S. Nat. Mus.; Segah River, northeastern Borneo, November 23, 1912; H. C. Raven; original number, 429. Pileum, cervix, sides of head and of neck, rather dark slate gray, paling to gull gray on forehead; upper back dark vinaceous brown; rest of back, together with the scapulars, haematite red; rump and upper tail-coverts, blackish slate; tail dull black, the tip rather deep neutral gray; wings dull black, the inner webs of the quills brownish; the outer edges of the secondaries, together with the greater coverts and outer middle coverts, marguerite yellow, the lesser coverts and exposed portion of the inner median coverts, haematite

[6] Named for Dr. W. L. Abbott.

red, middle of chin dull white; sides of chin, together with the throat, slate gray, lighter medially; jugulum raw sienna; breast between oil yellow and pyrite yellow; abdomen vetiver green; sides slate gray, washed inferiorly on the anterior portion with the color of the breast, on the posterior portion with vetiver green; flanks blackish slate, mixed with tawny and washed anteriorly with vetiver green; thighs tawny; crissum between auburn and chestnut; lining of wings blackish slate.

Measurements of type.—Wing, 114.5 mm.; tail, 71.5; exposed culmen, 13.5; height of bill at base, 5; tarsus, 19; middle toe without claw, 20.5.

This new subspecies is evidently not the same as *Dendrophassa olax hageni*[7] from northeastern Sumatra, since that bird is described as paler than *Dendrophassa olax olax*, while the Borneo birds are darker than the typical race.

Butreron capellei messopora, subsp. nov.

Subspecific characters.—Similar to *Butreron capellei passorhina* Oberholser from Pulo Mata Siri, but pileum more greenish (less grayish); upper parts darker; greenish areas of lower surface, except the flanks, darker; breast and abdomen more yellowish as well as darker.

Description.—Type, adult male, no. 181425, U. S. Nat. Mus.; Klumpang Bay, southeastern Borneo, January 22, 1908; Dr. W. L. Abbott. Forehead olive gray, lighter anteriorly, and washed all over with greenish; crown greenish gray, washed with greenish; hind neck vetiver green, slightly tinged with citrine; scapulars the same; back and rump, darker, between vetiver green and andover green; upper tail-coverts dull vetiver green; broad tips of middle pair of rectrices between light yellowish olive and mignonette green, remainder of exposed portion deep grape green, and the basal concealed portion deep gull gray, more or less washed with the same green; the remaining rectrices dusky neutral gray, basally deep gull gray on outer vanes, light neutral gray on the inner, and terminally pale neutral gray, the two pairs next to the middle pair washed with the green of the middle feathers, particularly on the outer webs, the outer rectrices also very slightly and narrowly tinged with the same on the outer margins of their gray tips; wings slate color, but the outer webs of the tertials and most of the lesser wing-coverts (excepting only those along the bend of the wing), together with a few of the inner middle coverts, between andover green and vetiver green like the scapulars; narrow edgings on outer webs of the inner middle coverts and some of the inner greater coverts, lemon yellow; and similar, but much broader, edgings on the two innermost greater coverts and on the outermost tertial and innermost secondary, lemon chrome; lores pale greenish olive gray; superciliary region, a narrow orbital ring, and the anterior malar region, greenish gray; remaining parts of the sides of the head, together with the sides of the neck, vetiver green; anterior part of chin between a dark yellowish glaucous and seafoam yellow; posterior portion of chin and middle uppermost part of throat, between dark citrine green and water green, middle of rest of throat rather dark lime green; a broad band on the jugulum yellow ochre, shading laterally to buckthorn brown; breast and abdomen between mignonette green and lime green; sides of body between tea green and water green; flanks between light slate olive and rather light sage green; shorter lower tail-coverts of the same green color, but mixed with feathers of cartridge buff

[7] *Osmotreron olax hageni* Parrott, Abhandl. K. Bayer. Akad. Wiss. II Kl. 24: abt. 1: 266. Nov. 6, 1907 ("Umgegend von Deli" [Sumatra]).

and pinkish buff, and some of the green feathers broadly tipped with the same buff; rest of lower tail-coverts hays brown; thighs partly dull green like the abdomen, partly cartridge buff; lining of wing partly slate gray, partly dark gull gray.

Measurements of type.—Wing, 193 mm.; tail, 128; exposed culmen, 25.5; height of bill at base, 10.5; tarsus, 26; middle toe without claw, 29.

Butreron capellei panochra, subsp. nov.

Subspecific characters.—Resembling *Butreron capellei messopora,* from Borneo, but upper and lower parts, excepting the crissum, lighter.

Type.—Adult male, no. 181058, U. S. Nat. Mus.; Besitan River, eastern Sumatra, February 8, 1906; Dr. W. L. Abbott.

Measurements of type.—Wing, 199.5 mm.; tail, 133; exposed culmen, 25; height of bill at base, 10.5; tarsus, 28; middle toe without claw, 31.

This race may be distinguished from *Butreron capellei magnirostris* of the Malay Peninsula by its lighter, more grayish (less greenish) upper parts, particularly the forehead; and lighter, more grayish (less greenish) lower surface (excepting the orange rufous pectoral band of the male).

The recognizable races of *Butreron capellei* are now five, as follows:

1. *Butreron capellei capellei* (Temminck). Java.
2. *Butreron capellei passorhina* Oberholser. Pulo Mata Siri, in the Java Sea.
3. *Butreron capellei messopora* Oberholser. Borneo.
4. *Butreron capellei panochra* Oberholser. Sumatra.
5. *Butreron capellei magnirostris* Strickland. Malay Peninsula.

CUCULIDAE

Surniculus lugubris massorhinus, subsp. nov.

Subspecific characters.—Similar to *Surniculus lugubris lugubris* of Java, and to *Surniculus lugubris dicruroides* of Nepal, but larger than either.

Description.—Adult female, no. 181212, U. S. Nat. Mus.; Siak River, eastern Sumatra, January 3, 1907, Dr. W. L. Abbott. Pileum metallic greenish slate black; cervix metallic bluish black; mantle metallic deep slate green; lower back, rump, tail, and wings, like the pileum, but the rump a little more greenish, the inner edges of the wing-quills fuscous, the tertials and superior wing-coverts, except the primaries and the outer greater and middle series, metallic deep slate green; lores and sides of head black, the latter with a metallic bluish or greenish sheen; sides of neck metallic bluish black; crissum metallic deep slate green, barred with dull white; remaining lower parts, together with the lining of wing, brownish black with a dull metallic greenish sheen.

Measurements of type.—Wing, 143 mm.; tail, 135; exposed culmen, 23; tarsus, 17; middle toe without claw, 15.3.

BUCEROTIDAE

Hydrocissa convexa barussensis, subsp. nov.

Subspecific characters.—Like *Hydrocissa convexa convexa,* from Sumatra, but larger, the length of wing much over 300 mm.[8]

[8] Measured *without* straightening the quills.

Description.—Type, adult, sex unknown, no. 179786, U. S. Nat. Mus.; Tana Bala Island, Batu Islands, in the Barussan Chain, western Sumatra, February 11, 1903; Dr. W. L. Abbott. Breast, and remainder of posterior lower parts, tail (excepting the two middle feathers), a short narrow patch on edge of wing, a bar across the extreme bases of primaries and secondaries, and broad tips of the same feathers, white; all the rest of the plumage black with a metallic greenish, in places purplish, sheen; bill ivory white, but the base of mandible, the posterior end of the casque, and a broad irregular stripe extending from the anterior point of the casque diagonally backward and downward to the middle of the base of the casque, black; "iris crimson brown; orbital skin and throat bluish white, deepest round eye; ear dull cobalt; feet gray black."

Measurements of type.—Wing,[9] 315 mm.; tail, 289; culmen from nostril, 145; height of bill (without casque) at nostril, 46; length of casque, 152; height of casque at nostril, 42; tarsus, 54; middle toe without claw, 43.

Birds of this species from the other islands of the Barussan Chain seem to be the same as those from Sumatra and Borneo. The wing in twelve specimens of *Hydrocissa convexa convexa* from Sumatra, Borneo, and the Barussan Islands measures 275–305 mm., with an average of 288 mm.

PICIDAE

Meiglyptes tukki hylodromus, subsp. nov.

Subspecific characters.—Similar to *Meiglyptes tukki tukki*, from Sumatra, but with light bars of upper and lower parts, particulary the former, less uniform and less extensive, therefore less conspicuous.

Description.—Type, adult male, no. 180846, U. S. Nat. Mus.; Mojeia River, Nias Island, Barussan Islands, western Sumatra, March 10, 1905; Dr. W. L. Abbott. Pileum between olive brown and chaetura drab; remainder of upper surface, including the scapulars, between olive brown and deep olive, barred with dark olive buff; tail olive brown, with lighter bars between cinnamon buff and isabella color; exposed surface of wings olive brown, the primaries and secondaries with fuscous bars of the same color as those on the tail, but the bars on the innermost webs cartridge buff; sides of head between hair brown and deep grayish olive; a streak on the side of the neck creamy buff; malar strip brazil red; chin dull cream buff, barred with light brownish olive; upper throat dull buffy white, barred with blackish brown; lower throat and jugulum brownish black, posteriorly barred with dull buffy; posterior lower parts between buffy brown and deep olive, barred with pale dull buffy, lining of wing cream buff.

Measurements of type.—Wing, 94 mm.; tail, 61; exposed culmen, 20.5; height of bill at base, 8; tarsus, 20; middle toe without claw, 16.

This new race is so very much smaller than *Meiglyptes tukki calceuticus*, of the neighboring Banjak Islands, that there is no difficulty in distinguishing it from that form.

Meiglyptes tukki percnerpes, subsp. nov.

Subspecific characters.—Similar to *Meiglyptes tukki tukki*, from Sumatra, but with lower parts paler and duller, the light bars there usually less sharply

[9] Measured *without* straightening the quills.

contrasted to the dark areas; black jugular band somewhat narrower; upper surface much paler, more brownish (less grayish), its light bars more ochraceous, and on the back rather broader.

Type.—Adult male, no. 181636, U. S. Nat. Mus.; Batu Jurong, southwestern Borneo, June 22, 1908; Dr. W. L. Abbott.

Measurements of type.—Wing, 99 mm.; tail, 65; exposed culmen, 21; height of bill at base, 8; tarsus, 21; middle toe without claw, 15.

PHODILIDAE

Phodilus badius abbotti[10], subsp. nov.

Subspecific characters.—Similar to *Phodilus badius badius,* of Java, but somewhat larger, and with upper parts and legs paler.

Description.—Type, adult, sex unknown, no. 172948, U. S. Nat. Mus.; Province Wellesley, Federated Malay States, western Malay Peninsula, 1899; Dr. W. L. Abbott. Forehead between light vinaceous fawn and vinaceous buff; crown, occiput, upper cervix, back, rump, and upper tail-coverts, between tawny and russet brown, spotted with dark brown; a collar on the lower cervix, together with the outer scapulars, bright ochraceous tawny, spotted with dark brown; tail russet, barred with black; wings russet, the lesser coverts mixed with ochraceous tawny along their median line and spotted with dark brown; face like the forehead, but the fringe all along the eyes, except on the outside, russet, mixed with rather reddish mars brown; a narrow collar on the throat rather reddish mars brown; below this a collar of creamy white; rest of lower parts like the forehead, but breast, sides, and flanks, mixed with a color between yellow ochre and ochraceous buff; thighs between pinkish cinnamon and clay color, paler on the inside; under wing-coverts dull white, tinged with buffy, the middle of these coverts russet.

Measurements of type.—Wing, 192 mm.; tail, 85; exposed culmen, 26; height of bill at base, 17; tarsus, 42; middle toe without claw, 33.

BUBONIDAE

Strix leptogrammica nyctiphasma, subsp. nov.

Subspecific characters.—Like *Strix leptogrammica myrtha* of Sumatra, but with face and forehead lighter, and the posterior lower parts darker, more rufescent, the dark bars therefore less distinct.

Description.—Type, adult male, no. 179099, U. S. Nat. Mus.; Pulo Bangkaru, Banjak Islands, Barussan Islands, western Sumatra, January, 1902; Dr. W. L. Abbott. Forehead russet, paler anteriorly; crown, occiput, and upper cervix, dark, rather rufescent bone brown; superciliary stripe and lower cervix between sanford brown and hazel, mixed to some extent with the paler color of the bases of the feathers; upper back between deep mars brown and warm sepia; back, rump, upper tail-coverts, and scapulars, between tawny and cinnamon brown and a lighter shade of the same, barred with the color of the crown, but the outer scapulars pale buff; wings and tail like the crown, barred with brown, varying from the color of the back to pale pinkish buff; lores dull white, the tips of the feathers blackish; ear discs like the superciliary stripe, but paler and mixed with whitish on their posterior edges; posterior auricular region like the crown; sides of neck, together with the chin, throat, and jugulum, brown like the superciliary stripe; remainder of lower

[10] Named for Dr. W. L. Abbott.

parts, including the thighs and the lining of the wings, cinnamon buff, but the crissum paler, the thighs darker, and all except the sides of the body barred with the brown color of the crown.

Measurements of type.—Wing, 293 mm.; tail, 176; exposed culmen, 30.5; culmen from cere, 23; height of bill at base, 23; tarsus, 46; middle toe without claw, 35.

This new owl has been found on only the Banjak Islands. It may be distinguished from *Strix lepogrammica niasensis*, from the neighboring island of Nias by its larger size.

The four recognizable races of this species are:

1. *Strix leptogrammica lepotogrammica* Temminck. Borneo.
2. *Strix leptogrammica myrtha* (Bonaparte.) Sumatra.
3. *Strix leptogrammica niasensis* (Salvadori.) Nias Island.
4. *Strix leptogrammica nyctiphasma* Oberholser. Banjak Islands.

ETHNOLOGY.—*The possible Siouan identity of the words recorded from Francisco of Chicora on the South Carolina coast.* F. G. SPECK (Communicated by J. R. SWANTON).

One of the most baffling problems of American ethnology has been that of the linguistic identity of the tribes inhabiting the coast of South Carolina in the sixteenth century. The meager information left to us by the early Spanish writers who dealt with the region has not been sufficient to dispel the mist of uncertainty as to whether their speech had its affinities with eastern Siouan tribes of whom the Catawba, Tutelo, and Woccon are typical, or whether their relationships were with the Yuchi or Muskhogean groups. Mooney in 1894[1] felt that the affinities of some of these unclassified languages were with Yuchi, while others were probably related to the eastern Siouan group, and the latter conviction has recently taken a more definite phase in the mind of Swanton.[2] Yet their inclination to this opinion rested more upon inferences drawn from the statements of a certain Indian, named Francisco of Chicora, who was taken by the Spaniards in 1521, and who, after his conversion, gave certain information to his captors, than upon any direct correspondence of words with the known eastern Siouan dialects so far as material in them is available. All authorities agree in accepting evidence of a similarity in phonetics and in the *-re* terminations in proper names and place names in the dialect in question as suggestive of Siouan affinity.

[1] JAMES MOONEY, *Siouan tribes of the East*, Washington, 1894.

[2] J. R. SWANTON, *Early history of the Creek Indians and their neighbors*, Bull. 73, Bur. Amer. Ethnology, Washington, 1922.

The descriptions of territory and the customs of the natives given by the Indian Francisco of Chicora applied to countries known as Chicora and Duhare which, after lengthy consideration, Swanton concludes to have been inhabited by some of the small tribes of eastern South Carolina supposed to be Siouan.

Any new deductions from the existing sources tending toward the further elucidation of the problem may be considered acceptable, so I present the accompanying notes which seem to lend a still more definite cast to the Siouan complexion of the tongues under consideration. Swanton, in his thorough survey of the problem, quotes at length from the account of Peter Martyr whose narrative, he says, has hitherto escaped ethnological investigators. By comparing the native terms given therein with Catawba linguistic material secured under the auspices of the Bureau of American Ethnology from the few surviving speakers of this interesting and important language during several recent periods of field work, I am able, I believe, to point out correspondences between the terms in the dialects of "Chicora" and "Duhare" and those in modern Catawba, to a degree which seems to carry the hitherto suspected Siouan determination to a more definite phase.

After looking over the evidence, Swanton adds the following comments in a letter to the writer, explaining more exactly the application of the term Cusabo and defining the supposed boundary between the Siouan and Muskhogean peoples. "I believe the region between the Cape Fear and Savannah rivers to have been occupied by both Siouan and Muskhogean peoples, the former extending southward as far as a point between the Santee River and Charleston Harbor, and the latter including Charleston Harbor and reaching the Savannah and beyond. It is these latter and not the Siouan tribes to which the term Cusabo is properly applied, though it was sometimes extended to include the Sewee and Santee. Francisco of Chicora was, I believe, taken from the Siouan section, somewhere near Georgetown Entrance. The names which he gives are partly those of Siouan tribes and partly, I think, of Cusabo (Muskhogean) tribes, though of course the latter will come to us in a Siouan form and some may even be in a Siouan dialect throughout. The facts do not affect the explanations of words and tribal names offered by you except possibly the last, Inziguanin, which I had thought to be a Cusabo tribe. However, even in that case the word itself may be Siouan."

In the first place it is a most striking fact that all of the syllables in the set of terms applying to Chicora and Duhare, even the two names

themselves, are typical of Catawba. The syllable sequence is also the same; that is to say, all of the terms could mean something in this language, since they represent perfectly possible sound combinations from the point of view of phonetics. The open, long vowels and the consonants occurring in Cusabo all appear in Catawba, and the frequent *r*, like the Spanish correspondent in its trill character, is exclusively eastern Siouan, not Muskhogean nor Yuchi. The endings *-are*, *-ora* and *-re* in three of the terms of Martyr's narrative are also exceedingly typical of Catawba, the *-re* being a predicative element. *Chicora* and *Duhare* are very likely eastern Siouan terms, as may be seen from the varied meanings which may be drawn from them merely in the one language of the group in which we possess enough material upon which to base comparisons.

PLACE AND PROPER NAMES IN CUSABO (from Martyr's relation—1521)	CORRESPONDENCES IN MODERN CATAWBA
Chicora, name of district near Winyaw Bay (Swanton).	*tcikóra* "going slowly," "going down hill" (*tcawakóra* full form), *kóra* "(to) go."

The relative position of the two peoples would have made it possible for the Catawba or other eastern Siouan peoples who resided on the Piedmont plateau to have referred to the coast inhabitants by using a comparative geographical designation. It seems rather more plausible than Gatschet's earlier suggestion; *chicora* = *yutcikere*, "Yutci over there" (Catawba).

Duhare, the name of a kingdom in the neighborhood.	*dugáre*, "(to) return." *hóhare*, "it does not come out." *yúhare*, "to let a thing alone." *dúheare*, "he eats."
Datha, a king's name. (In contemporary Spanish the *th* was pronounced as *t* + *h*, not as in English.)	*táte* (*nÁ*) "grandfather (my)." *dAt*, "up." *ye^{n}t* Ã' *swà^{n}'* "governor, chief."
Xapida, (Xapira) a place name, a town. (The *x* in 17th century Spanish was pronounced like English *sh*.)	*hápi-* (*re*), "here." *yapi·té^{n}*, "flat wood, board." *supì·'*, "trash."
Xathi, a cereal eaten by the Indians	*witì·*, "root, medecine." (*-ti* "root")
Xamunambe, a place name	*yámu*, "in the water,"—*nàmpere* "two." *sámu*, "mouth."
guahi (=*wahi*), an emetic herb	*wa*, a prefix used in plant names. *wá·tap*, pumpkin, *wàkta*, blackberry, *wapAtù'*, muscadine, *wanAkù'*, hickory). *-hi*, "the," or "like," demonstrative element.

Next we have two proper names commencing with the syllable *in-*. This is most suggestive of eastern Siouan, Catawba *yeⁿ(n)-*, person, human being, male.

Inamahari, name of two wooden idols to which offerings were made.	*yenwahári,* people who never die. *wáriwe,* "God, he who never dies." (*wahàriwe*).
Inziguanin, Inzignanin, people with long tails like alligators who inhabited a neighboring province. Probably alluding to a myth, cited by Swanton as being common in the Southeast.	*yeⁿn sigrire,* "people stingy," or "people spoiled," also referring to "saltwater" (*iswàⁿ-sigrì-*) "river spoiled, salty, the ocean."

Several other terms in the language of Chicora are interesting, for instance the ending *-xungwa, -xuga* occurring in the designations of the god of the north and the god of the south. But no correspondence with them is apparent from a survey of existing Catawaba terms.

The similarity between the forms in the documents and those of Catawba is suspicious considering that the accounts were written four hundred years ago by a scribe who did not always spell his words twice in the same way. Besides, the distance between the two languages was something over 150 miles, and the Catawba, an inland Siouan people, have very few terms that would apply to the geography of the coast. I think that Swanton's statement (op. cit., p. 47); "We may feel pretty certain that both (Chicora and Duhare) were in Siouan territory, but more than that we can not say with any degree of assurance," receives a little more assurance from what has just been shown.

SCIENTIFIC NOTES AND NEWS

David White, of the U. S. Geological Survey, has been elected chairman of the Division of Geology and Geography of the National Research Council for the year beginning July 1, 1924.

G. F. Loughlin has been appointed Geologist in Charge, Section of Metalliferous Deposits, of the U. S. Geological Survey to fill the vacancy caused by the resignation of F. L. Ransome, and F. J. Katz has been made Geologist in Charge, Division of Mineral Resources, the position vacated by Mr. Loughlin.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 14 August 19, 1924 No. 14

GEOLOGY.—*Oceanography in its relations to other earth sciences.*[1]

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INTRODUCTION

The earth is composed of five more or less concentric shells of material, which are known as the centrosphere, the asthenosphere, the lithosphere, the hydrosphere, and the atmosphere. Oceanography deals primarily with the hydrosphere, or more precisely that part of the hydrosphere contained in the ocean. As the hydrosphere lies between two of the other spheres, its relation to them is physically most intimate, and to understand it, attention may not be confined merely to the adjacent spheres, but it is necessary in imagination to pierce the subjacent lithosphere and proceed to the innermost part of the earth. Oceanography must, therefore, concern itself with all recognized branches of geophysics. In its relations to geology it transcends the bounds usually set to geophysics and passes into the field of biology, for the present ocean holds the key to the significance of the remains of most organisms contained in the stratified rocks and the ocean alone can reveal the nature of many geologic processes which are dependent on the activity of organisms and were operative in the past and are operative at the present time as well.

In an address such as this, it is not possible to review all the subjects I have indicated. The most that I can aspire to do is to point out some of the reciprocal relations between oceanography and other earth sciences. From some of these sciences oceanography may be the principal beneficiary, to others it may make contributions of

[1] Address of the retiring president, Washington Academy of Sciences, Washington, Jan. 8, 1924.

fundamental importance. Although terrestrial magnetism is one of the important earth sciences, and investigations in it need to be conducted on the sea as well as on the land, I shall only mention it now and shall not give it further consideration in subsequent remarks.

Since my chief scientific activity has been in geology, I may be permitted to emphasize certain geologic relations and to dwell on my beloved bottom muds.

Washington scientific men have been fortunate in that they have recently had opportunities to hear excellent presentations of the results of two kinds of investigations which concern the lithosphere, both where it is and where it is not overlain by water. I refer to Dr. A. L. Day's lecture on the work of the Earthquake Committee of the Carnegie Institution of Washington and Dr. David White's address on the relation of gravity-anomalies to the density of geologic formations. These addresses might be appropriately classified as oceanographic, for both of them dealt with features of the lithosphere, and 71 per cent of the lithosphere lies under the ocean. Doctor Day did project his studies under the waters of the Pacific as far out from the land as the 2,000 fathom curve. To both of these gentlemen I extend my very warm thanks, for they have helped me greatly.

CONFIGURATION OF THE LITHOSPHERE

The total area of the earth according to Sir John Murray[2] is 196,499,000 sq. mi., of which 57,254,000 is land and 139,245,000 water. That is, about 29 per cent of the surface of the earth is land and about 71 per cent of the surface is water. Therefore, 71 per cent of the surface relief of the lithosphere is under the ocean and only 29 per cent above sea level. It will be generally admitted that considered as knowledge of the earth, it is as important to know the configuration of that part of the lithosphere below, as well as that part above, sea level. It is a scientific misfortune that so many of our maps stop the indications of relief at the shore, and it is hoped that this defect may very soon be remedied. In fact, some recently published maps are contoured for the areas both above and below sea level.

Although the configuration of the sea bottom is very inadequately known, there is available a considerable body of information—at least enough to make approximations to actual conditions. The

[2] Murray, Sir John, and Hjort, J., *Depths of the Ocean*, p. 132, 1912.

average depth of the ocean is greater than 12,000 ft. and less than 18,000 ft., while the average height of the land is probably about 2,400 ft.[3] The average ocean depth, therefore, is more than 5 times the average height of the land. The greatest depths of the ocean are a little over 30,000 ft., and somewhat exceed the greatest height of the land. Although from present information it seems that vast areas of the sea-floor are low-lying plains, as most of the eastern Pacific, not all of it is so nearly flat. Two areas adjacent to America in which there is great or considerable relief are the Caribbean region and the sea-bottom off the coast of California south of San Francisco.

Surveys of the sea-bottom supply only empirical data on relief, just as topographic surveys supply only empirical information on the surface features of the land above sea level. How are the features to be explained?

In order to answer this question it is necessary to know all those forces that have caused the earth to deviate from the shape of the theoretical spheroid of revolution and assume that of a geoid. To say that the oceanic basins are underlain by heavier and the continents by lighter material—and this is generally accepted as true—is not sufficient, for the boundaries between the land area and the sea bottom are neither uniformly abrupt nor gradually shelving. Such lack of uniformity in the nature of the boundary is indicative of heterogeneity in the composition of the lithosphere on the one hand and of differential movement on the other. We are, therefore, brought face to face with the problem of the relative weights of the constituents of the different columns of earth substance and the forces that produce differential movements in the earth's crust.

In order to get more information on the density of the material underlying the oceanic basins, gravity determinations at sea are essential. We need for the sea such data as we now have for the land area of the United States, and it is hoped that the recent inventions of Professor Michelson and Dr. F. E. Wright will render the needed measurements practicable.

The study of the dynamics of geologic structures is just as essential in oceanography as in the study of those structures exposed to view on land surfaces. It is well known that the contact zones between continent and ocean are or were sites of great earth movements and adjacent to the sites of such movements there are important volcanic zones. It is necessary only to mention the earthquake

[3] Geikie, A., Textbook of Geology, 4th edit., 1: 49. 1903.

zone and the so-called ring of fire of the Pacific. Radial contraction of the earth seems to be accepted by both the adherents of the Kant-Laplace and of the planitesmal hypotheses of the origin of the earth. Geologists are all convinced of important tangential thrusting near the surface of the earth as well as vertical displacement, although only a few accept the hypothesis of continental drift advocated by Wegener. Notwithstanding agreement about a few general principles underlying geologic structures, relatively little is known. More energetic investigation of these features of the earth should be advocated and supported by geodesists, geologists, and oceanographers. In this connection the work of the Earthquake Committee of the Carnegie Institution of Washington and the coöperating institutions deserves the highest commendation.

The kinds of configuration of the ocean bottom so far considered are the major features, the ocean basins and the more or less submarine ridges with their associated submarine troughs or other depressions. These are the great tectonic features of the ocean on which other forces play.

In the sea, forces are operative which tend to bring the sea bottom to the great base-level of the sea—wave-base. Above wave-base, there is marine erosion which tries to cut down all that stands above it, while below it sedimentation tries to raise the bottom to that level. In some places in the sea agencies tend to fill the sea above wave-base, but such filling, unless the access of new material exceeds in rate the capacity of the waves to cut, must be only temporary. The accumulation of sediment on the sea bottom is not merely due to detritus washed from the land. The most wide-spread deposits in the sea are composed of the remains of organisms which build their skeletons out of substances dissolved in the sea-water. Some of the organic rocks, coral and algal reefs for instance, may have distinctive form.

A number of factors may cause sea-level itself to fluctuate, for a glacial epoch will lower sea-level and deglaciation will raise it; an overdeepening of an oceanic basin will draw the sea downward from the land; and an elevation of the sea-bottom or the accumulation of sediment in the sea will cause the ocean to overflow its shores. The land surface may go down. Currents and waves affect the shore and the bottom below it at least as deep as wave-base—and currents may be effective to even greater depths.

The results of all these processes is to produce a submarine physiography of great complexity. This physiography has not received

the attention it deserves, and until it has been sufficiently studied many phenomena of importance both in understanding the ocean itself and the geologic history of adjacent land areas cannot be adequately explained.

Wave-base has been mentioned. What is the depth of wave-base off different kinds of shores and under different climatic conditions? Except in a very general way, I think it safe to say no one knows. A thoroughgoing investigation of the profile of submarine equilibrium is one of the outstanding needs of the physiographic side of oceanography.

CLIMATOLOGY AND OCEANIC CIRCULATION

Atmospheric circulation and oceanic circulation are comparable in that both are due to the same fundamental causes, viz., the rotation of the earth on its axis, the heat of the sun, and the rugosities of the lithosphere. A subaerial mountain range will affect the movement of the air, while a submarine mountain range will affect the movement of oceanic water. Of course, the air envelops the entire earth, while the ocean covers only about 71 per cent of its surface.

There is a well known reciprocal relation between the air and the ocean. For instance the trade winds tend to drive the surface water of the tropics and subtropics westward and produce a westward-setting surface current. Admiral Pillsbury's explanation of the Gulf Stream is known to all of you and I need not repeat it. The relation between the land climate of western Europe and the temperature of the north Atlantic and between the land climate of the western part of America and the temperature of the adjacent part of the north Pacific is common information. It is also known that a very high barometer will depress the surface of the ocean, which will rise where the pressure is low. There are other generally recognized interrelations between the air and the sea.

It appears that the acquisition of more detailed information on the temperature of the surface waters of the ocean and of atmospheric conditions over the sea may render assistance in forecasting what the weather on the adjacent continents may be. This is a field in which some but not nearly enough work has been done and it should be cultivated more assiduously.

That knowledge of oceanic circulation is of the utmost importance to man in navigation is obvious to everyone, and deficiencies in knowledge are recognized and deplored. Besides the value of the information for such purposes, it is also needed in order to under-

stand the factors controlling the geographic distribution of numerous marine organisms; and knowledge of the interrelation between organisms and currents can be projected backward in time and utilized in interpreting the geologic record.

MARINE SEDIMENTS

Marine sediments cover most of the sea-bottom, about 71 per cent of the earth's surface, and perhaps about 60 per cent of the land surface of the earth, or approximately 90 per cent of the entire surface of the earth. If areal extent is an index of relative importance, the marine sediments are by far the most important class of rocks at the surface of the earth. The thickness of 0.5 mi. assigned to the sedimentary rocks by Professor Clarke in his *Data of Geochemistry* is, I think, too low. The actual thickness is not known, and this, therefore, is another subject that should receive prompt and comprehensive consideration.[4]

I shall not attempt to give any general review of marine sediments. It can not be done in the time permissible for this address. I will state that as the ancient marine sediments can be interpreted only by the light derived from the study of modern sediments, the study of modern sediments is a geologic necessity. I will now pass to the consideration of certain special sediments, viz., calcium-carbonate sediments.

CALCIUM CARBONATE SEDIMENTS

The calcium carbonate contained in or composing sediments is deposited from solutions either in contact with the tissues of organisms or by physical or chemical processes which may or may not be dependent on the activities of organisms. The original source of the calcium carbonate is the crust of the earth. According to F. W. Clarke and H. S. Washington's estimate of 1920[5] the average amount of CaO in the earth's crust is 5.08 per cent and that of CO_2 is 0.102.

Clarke in his *Data of Geochemistry* assumes that the lithosphere consists of 95 per cent igneous and 5 per cent sedimentary rocks. He distributes the 5 per cent of sedimentary rocks as follows: Shales, 4; sandstones, 0.75; limestones, 0.25. In modern deep-sea sediments

[4] See Chamberlain, T. C., *The age of the earth from the geological view point.* Proc. Amer. Phil. Soc. **61**: 254–255. 1922.

[5] Washington, H. S., *The chemistry of the earth's crust*, Journ. Franklin Inst., p. 773, 1920.

$CaCO_3$ is about 32 per cent, and if this ratio should hold for sediments in general, the $CaCO_3$ ratio is much higher than is usually supposed; limestone should be not 0.25, but $5 \times 0.32 = 1.60$, or Clarke's figure may be less than one-sixth of what it should be; or $5 \times 0.2175 = 1.0880$ if all the $CaCO_3$ at the surface of the earth were confined to the deep-sea bottom.

TABLE 1—PERCENTAGE OF $CaCO_3$ IN MODERN DEEP-SEA SEDIMENTS
(Data taken from *Challenger* report)
Area of the Earth: 196,470,700 sq. mi.

(1) NAME OF DEPOSIT	(2) AREA IN SQ. MI.	(3) PER CENT OF AREA OF THE EARTH	(4) PER CENT OF $CaCO_3$	(5) PRODUCTS OF FIGURES IN COLUMNS (3) AND (4)
Red clay	51,500,000	26.2	6.70*	26.2 × 6.70 = 175.54
Radiolarian ooze	2,290,000	1.1	4.01	1.1 × 4.01 = 4.41
Diatom ooze	10,880,000	5.5	22.96	5.5 × 22.96 = 126.28
Globigerina ooze	49,520,000	25.2	64.47	25.2 × 64.47 = 1624.64
Pteropod ooze	400,000	0.2	79.25	0.2 × 79.25 = 15.85
Coral mud, Coral sand	2,556,800	1.3	85.53	1.3 × 85.53 = 111.89
Volcanic mud, Volcanic sand	600,000	0.3	20.49, 28.79 } 29.64	0.3 × 29.65 = 8.89
Green mud, Green sand	850,000	0.4	25.79, 49.78 } 37.65	0.4 × 37.64 = 15.06
Red mud	100,000	0.05	32.28	0.05 × 32.28 = 1.61
Blue mud	14,500,000	7.3	12.48	7.3 × 12.48 = 91.10
		67.55		2175.27

$$\frac{2175.27}{67.55} = 32.20 \text{ per cent.}$$

$$CaCO_3 = 32.20 \text{ per cent; } CaO = 32.20 \times \frac{56}{100} = 18.03 \text{ per cent}$$

$$\text{Concentration of CaO in deep-sea sediments} = \frac{18.03}{5.08} = 3.55 \text{ times the percentage in the}$$
average for the earth's crust.

* Mr. George Steiger informs me orally that the $CaCO_3$ in red clay is about 9 per cent.

There is great need for more accurate investigations of the chemical composition of sedimentary geologic formations with the determination of the areas, thickness, and volumes of the different formations so that estimates of the average composition of the sedimentary rocks may be rendered possible. There is strong evidence of con-

centration of $CaCO_3$ in marine formations and it seems that this has escaped the notice of most geologists.[6]

DERIVATION OF CALCIUM FROM THE ORIGINAL CRUST OF THE EARTH

The calcium is derived from the constituents of the original earth substance by the action of acid radicles that would produce soluble calcium salts. These salts are not necessarily $CaCO_3$, which would result from the action of CO_2 on calcium compounds. $CaSO_4$ and $CaCl_2$ are also water-soluble calcium salts and $CaCO_3$ may be formed from either of them by adding a strong alkaline carbonate, such as $(NH_4)_2\,CO_3$, K_2CO_3, Na_2CO_3 or bicarbonate, according to the equation for the sulphate,

$$R_2CO_3 + CaSO_4 = CaCO_3 + R_2SO_4,$$

in which R represents a monovalent alkaline base.

It seems more probable that the principal solvents of Ca were waters containing CO_3 and SO_4 radicles. Clarke in his *Data of Geochemistry* properly attributes the greater amount of solution to carbonated waters, but I wish to enter a plea for more consideration of the sulphate radicle.

Chlorine might be an important solvent were it not for the greater affinity of Na for Cl, especially in the presence of CO_3 and SO_4 radicles. The discrepancy between the amounts of Na and Cl in the rocks and of Na and Cl in the ocean has been recognized by several geophysicists and chemists. There is a known excess of Cl to an amount of about 50 to 1. Several attempts have been made to explain this discrepancy. F. C. Brown[7] postulates that both Na and Cl are derived by radioactive processes, and that in the evolution of these elements the amount of Cl in comparison with the amount of Na in the present average composition of the earth's crust has outrun the proportion of Na and thereby produced the discrepancy. Professor Chamberlin suggests that there may be a return of the sodium of the ocean to the solid state in the ocean sediments[8] and that the discrepant ratios of Na and Cl in the ocean as compared with the parent rocks may thereby be explained. Notwithstanding the discrepant amount of Na and Cl, in whatever way the fact be explained, there is enough

[6] Leith and Mead, in their *Metamorphic Geology* recognize such a concentration of $CaCO_3$.

[7] Brown, F. C., *Sur un preuve que le sodium appartient a une serie radioactive d'élément,* Le Radium, 9: 4. 1912.

[8] Proc. Amer. Phil. Soc. 61: 264. 1922.

Na to combine with Cl and we have no important amount of Cl in our atmosphere. Therefore, it seems probable that Cl was not an important acid radicle in the original solutionof Ca from the parent rocks.

Two calcium salts, therefore, seem to be the sources of the important deposits of limestone, viz., $CaSO_4$ and $CaCO_3$.

CHEMICALLY PRECIPITATED CALCIUM CARBONATE IN THE OCEAN

The presence of large quantities of finely divided calcium in the vicinity of the Florida Keys was recognized long ago. In 1863, E. B. Hunt[9] described the so-called white-water periods, which are due to the stirring up of the fine-grained calcium-carbonate muds by storms. Nearly fifty years later Sanford[10] said, "other deposits, such as the marls accumulating on the bottom of Whitewater Bay, have been precipitated from solutions in ways not clearly understood."

My own studies of the problem were an outgrowth of an investigation of the oolitic limestones of southern Florida which I began in February, 1908. From the structure of the oolite grains, the opinion was reached by Messrs. Sanford, Clapp, and Matson and myself that the grains were formed by chemical agencies which caused precipitation of calcium carbonate in concentric shells outward from an interior nucleus.

In the hope that oolite might be found in process of formation, I undertook in the summer of 1908 a detailed study of the bottom deposits in the bays and sounds of the Key region of Florida. Some results of these studies were published in 1910 in a paper by me on the geologic history of the Floridian Plateau.[11] Mr. Geo. C. Matson made mechanical analyses of the bottom samples and described the separates. This was a first attempt at such work by both Mr. Matson and me and in the light of later experience it is crude, but, nevertheless, valuable information was procured.

From the field studies of Mr. Sanford and myself it was found that the soft calcareous mud was in places 10 ft. or more in depth and from the microscopic examination of the finest separates I said "that the accumulation on the sea-bottom of large quantities of

[9] Amer. Journ. Sci., 2d Ser., **35**: 200. 1863.

[10] Florida Geol. Survey., 2d. Annual Report, 228. 1910.

[11] Vaughan, T. W., *A contribution to the geologic history of the Floridian Plateau,* Carnegie Inst. Washington, Pub. **133**: 99–185. 1910.

amorphous calcium carbonate, apparently not of detrital origin, is undeniable."[12]

The interpretation of a part of the finely divided calcium carbonate deposits of the Floridian region as a chemical precipite by Mr. Sanford and me was new and the correctness of our conclusions has been abundantly corroborated by subsequent investigations.

PHYSICAL, BIOLOGIC, AND CHEMICAL FEATURES OF THE MUDS[13]

The following are the results of mechanical analyses of several samples which are about typical of the class of deposit under consideration:

MECHANICAL ANALYSES OF BOTTOM SAMPLES

STATION NUMBER	2-1 MM.	1-0 5 MM.	0.5-0.25 MM.	0.25-0.10 MM.	0.10-0.05 MM.	0.05-0.005 MM.	0.005-0 MM.
B.s. 87	1.0	1.6	1.7	10.2	25.1	25.8	35.4
88	0.6	1.9	4.3	16.1	27.9	19.5	30.3
177	1.6	4.5	5.0	6.3	12.2	31.1	40.1
261	1.2	2.9	4.0	30.4	23.7	11.3	26.3
262	0	0.1	0	0.2	0.5	29.5	69.8

Silt + clay for Nos. 87, 88, 177, 261 .... average 55.0 per cent
Clay for Nos. 87, 88, 177, 261 .... average 35.5 per cent

Explanation of station numbers:
B.s. 87, Bahamas, 1 mi. w. of w. mouth of South Bight, depth 1 fm.
88, Bahamas, 3 mi. w. of w. mouth of South Bight, depth 8 ft.
177, Bahamas, 2 mi. w. of w. mouth of South Bight, depth 1 fm.
261, Bahamas, 1 mi. w. of w. mouth of South Bight, depth 8 ft.
262, Florida Keys, east of Sugar Loa fKey, north side of Loggerhead Key, depth about tide level.

[12] Carnegie Inst. Washington, Pub. **133**: 136. 1910.

[13] Prof. Richard Field has applied the name "drewite" to the fine-grained deposits in Tortugas lagoon, Carnegie Inst. Washington, Yearbook **18**: 197. 1920, but he does not define the term petrologically, physically, chemically, or otherwise. Later, Dr. E. M. Kindle, Pan-American Geologist, **39**: 368–369. 1923, used the term "drewite", but he also gives no adequate description of it. However, he designated as the typical locality of "drewite", the shallow-sea bottom of the Great Bahama Bank, west of Andros Island. "Drewite" is not recognizable from the definitions of either Field or Kindle. I know from a study of material from the two areas that the "drewite" of Field is not the "drewite" of Kindle. If "drewite" should be accepted as a name, it should be applied to the kind of deposit Field had in mind. It is my opinion that investigations have not yet advanced far enough to warrant any fixed nomenclature for such deposits. If a temporary name is desired, Grabau's term "calcilutite" might be applied to the "drewite" of both Field and Kindle, but Grabau's term was proposed for indurated calcium carbonate muds.

The striking feature of these analyses is the high percentage of particles of silt and clay sizes.

The small amount of material of the larger sizes is composed principally of foraminifera referred to *Orbiculina adunca* (Fichtel and Moll), but there are some *Sorites duplex* (Carpenter) and shells of small mollusks. The intermediate sizes are composed of smaller foraminifera and ellipsoidal aggregates of minute particles of calcium carbonate, mostly aragonite needles.[14] The ellipsoidal aggregates are particularly characteristic of the Bahamian deposits. The finest sizes are aragonite needles[15] and particles so minute as to be visible only with a very high power of the microscope or the ultramicroscope. Many of the small particles show distinctly under polarized light and, therefore, are probable crystalline. The smaller aragonite needles and the other minute particles exhibit vigorous Brownian movement.

As it seemed that there was an appreciable amount of particles of colloidal size in these muds, I requested Prof. Milton Whitney to test several samples for their probable colloidal content.

In the first specimen submitted (b.s. 261) it was estimated on the basis of the adsorption of water vapor that there was 8.6 per cent colloid.

I then submitted about a quart of mud from the west side of Andros Island, Bahamas (b.s. 177) in the hope that enough colloid might be extracted for a chemical analysis. Professor Whitney reported:

"In an attempt to separate out colloidal material from the sample at our disposal we used a small high-speed centrifuge the inside dimensions of the bowl being 1.75 inches in diameter, 0.875 inch in radius and the length of the bowl was 7.5 inches. Running this centrifuge at a speed of 28,000 revolutions per minute we obtained a solution of considerable turbidity in which, however, we found a large number of needles which we assumed to be aragonite having a diameter of about one-tenth micron and varying in length from 1 to 4 microns. As the persistence of organized material in liquids passing through this centrifuge at this velocity is very unusual the remainder of the sample was made quite dilute so as to have sufficient volume to pass through our larger centrifuge. The internal dimension of the bowl of this larger centrifuge is 4.125 inches in diameter or 2.0625 inches in radius while the length of the bowl is 22.75 inches. The solution was passed through this centrifuge which was operating at about 17,000 revolutions per minute. In

[14] H. E. Merwin determined these needles to be aragonite.

[15] For photomicrographic illustrations see Vaughan, T. W., Bull. Geol. Soc. Amer. **28**: pl. 47, fig. 6, 1917; and *Coral and the formation of coral reefs*, Smithsonian Rept. for 1917, pl. 32, fig. 3, 1919.

the solution so prepared no aragonite needles could be distinguished by the ultra microscopic nor could any definite evidence be found of colloidal droplets.

"The turbid solutions passing through the small centrifuge were then passed through a Pasteur-Chamberlain filter tube under suction, the material collecting on the outside of the tube being occasionally detached by reversing the current and putting a pressure on the inside of the tube when the material detaches itself and slides off into a dish. This concentrated material was put on a plate that was slightly warm in order to hasten the evaporation of the small amount of liquid when it began to swell up with bubbles evidently CO_2 escaping at a temperature somewhat above room temperature. This was an indication of a considerable amount of bicarbonate being present which may have been formed through the passage of air during the time taken to filter the water off through the Pasteur-Chamberlain tube. As it was evident that some change has occurred in the material it was felt that satisfactory results could not be obtained by carrying the matter further.

"As the conditions in the material seemed to be very delicately adjusted we took some of the original solution that had passed through the smaller centrifuge and which contained what appeared to be small aragonite crystals and passed in CO_2 when the suspended material was entirely dissolved and an apparently clear solution was obtained. One portion of this was put in the vacuum desiccator when a profusion of CO_2 bubbles were given off. A small amount of solids separated out with the escaping of the gas which were found to be calcite. Another portion of this clear solution was gently warmed on a hot plate, somewhat above the room temperature, to drive off the CO_2. A number of crystals formed which under the ultra microscope were identified as a mixture of calcite and aragonite needles."

In compliance with a suggestion from Professor Whitney, I requested Dr. Paul Bartsch to get for me a large sample of mud at a locality along the Florida Keys where I knew the material was very fine grained. This specimen contained 69.8 per cent of particles of clay size but the percent of colloid has not yet been determined.

The results of these tests was to show that much of the fine material in these samples consists of particles of colloidal size, thereby corroborating an inference that would be drawn from the Brownian movement so well exhibited.

The Bahamian samples differ from the Floridian samples by having a far greater abundance of neat, very distinct aragonite needles. There are some aragonite needles in the Floridian samples, but many of the small particles appear to be rhombs and are probably calcite, but this feature needs more careful study.

CHEMICAL COMPOSITION OF THE MUDS

The following are chemical analyses of several of the muds and specimens of oolite:

CHEMICAL ANALYSES OF OOLITE AND BOTTOM SAMPLES FROM FLORIDA AND THE BAHAMAS*

(By W. C. Wheeler)

	OOLITE, BOCA GRANDE KEY, FLORIDA	OOLITE, EVERGLADES, MIAMI, FLORIDA	OOLITE, SHARP POINT, ANDROS ISLAND	BOTTOM SAMPLE† (98), EAST SIDE MARQUESAS LAGOON, FLORIDA	BOTTOM SAMPLE‡ (87), 1 MILE WEST OF WEST END OF SOUTH BIGHT, BAHAMAS
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
SiO_2	0.03	8.23§	0.07	1.13	0.28
Al_2O_3	0.18	0.00	0.00	0.14	0.03
Fe_2O_3	0.22	0.21	0.13	0.21 (total Fe)	0.11 (total Fe)
MgO	Trace	Trace	Trace	1.31	1.25
CaO	53.77	51.60	54.57	51.04	52.30
Na_2O	0.90	0.11	0.14	...	...
K_2O	Trace	Trace	Trace	...	...
H_2O	1.21	0.17	1.72	2.03 (and organic)	3.16 (and organic)
CO_2	42.34	40.11	43.07	41.50	42.45
P_2O_5	Trace	Trace	Trace	...	...
SO_3	0.28	Trace	0.14	...	...
Cl	1.02	0.08	0.03	...	...
Soluble	....	....	....	2.21‖	...
Total	99.95	100.51	99.87	99.57	99.58

Reduced analyses (hypothetical combinations); H_2O, organic matter, and soluble salts rejected; silica not essential

SiO_2	0.03	8.19	0.07	1.18	0.29
$(Al, Fe)_2O_3$	0.42	0.21	0.13	0.37	0.15
$MgCO_3$	Trace	Trace	Trace	2.88	2.72
$CaCO_3$	99.05	91.60	99.56	95.57	96.84
$Ca_3P_2O_5$	Trace	Trace	Trace	.....	.....
$CaSO_4$	0.50	Trace	0.24	.....	.....
Total	100.00	100.00	100.00	100.00	100.00

* Vaughan, T. W., Geol. Soc. Amer. Bull., **28**: 937. 1917.

† Sample washed and dried over H_2SO_4.

‡ Sample filtered, washed, and dried ever H_2SO_4.

§ Twenty-five per cent soluble SiO_2; the rest of the silica appears to be white sand.

‖ Saline salts not washed out by water in the preparation of the sample.

Sample of Mud from the Bahamas, b.s. 261.

(Chemical analysis by E. Theodore Erickson)

		Calculated as:	
SiO_2	0.22	SiO_2	0.22
Al_2O_3	0.21	Al_2O_3	0.21
Fe_2O_3	0.06	Fe_2O_3	0.06
MgO	0.66	$CaCO_3$	89.62
CaO	50.19	$MgCO_3$	1.39
H_2O	0.79	$SrCO_3$	0.93
		$CaSO_4$	0.68
Organic matter and H_2O +	5.86	Organic matter and H_2O +	5.86
TiO_2	None		
CO_2	40.60	H_2O	0.79
P_2O_5	Trace	$(Ca)_3\ (PO_4)_2$	Trace
SO_3	0.51	MnO	Trace
MnO	Trace	TiO_2	None
SrO	0.63		
	99.73		99.73

Ignited insoluble .... 0.35 per cent
Ignited insoluble, other than SiO_2 .... 0.13 per cent

When received at the chemical laboratory this sample was "pasty" with an excess of moisture. It was dried to "apparent" dryness at 105°C. for several hours and the above analysis was then made on the dried sample.

It is interesting that strontium is present in this sample.

An examination of sample, b.s. 261, Andros Island, Bahamas, by Mr. Erickson showed the presence of organic matter, but neither its amount nor its nature was ascertained.

Prof. Milton Whitney had a partial chemical analysis and a determination of the water-adsorption value made of the colloidal part of b.s. 262 from Florida and reports as follows:

Partial Chemical Analysis of Colloid from b.s. 262.

	Per cent	Rejecting loss on ignition
SiO_2	2.78	8.02
(TiO_2, Fe_2O_3, Al_2O_3, P_2O_5	2.86	8.25
CaO	20.15	58.10
MgO	8.89	25.63
Loss on ignition	62.04	.....
Total	96.72	100.00

It is interesting to note that the mineral part of this material is mostly composed of calcium and magnesium salts, of which the calcium are more than twice the amount of the magnesium salts, and that SiO_2 and $Fe_2O_3 + Al_2O_3$ together aggregate less than one-third of the amount of the CaO. The MgO content is relatively high and differs significantly in amount from that found in the oolitic limestones. It appears that there are chemical features of these muds that are as yet far from being understood and that additional research is needed.

THE LOCUS OF CHEMICALLY PRECIPITATED $CaCO_3$ IN THE OCEAN

The shoal-water calcium-carbonate deposits have now been studied for several areas in tropical and subtropical regions. Dr. M. I. Goldman made a very detailed study of the reef sands of Murray Island, Australia, and later he has made a similar study of sands collected behind the reef at Cocoanut Point, Andros Island, Bahamas; and M. N. Bramlette has just completed a quantitative determination of the different ingredients of the bottom samples of Pago Pago Harbor, Samoa. No chemically precipitated calcium carbonate was recognized in any of the samples from the three localities mentioned. Besides these detailed studies by Messrs. Goldman and Bramlette, I have examined numerous bottom samples in a more or less cursory way. The chemically precipitated material, which is identified chiefly by the aragonite needles, is known only under peculiar environmental conditions. The present sites of its undoubted occurrence are chiefly the shallow mud flats on the leeside, the west side, of Andros Island, Bahamas, and some of the flats behind the Florida Keys. Many of the samples I have collected need to be restudied in the light of the wider experience acquired since the investigation of such deposits was undertaken, and the present known extent may be somewhat increased.

The natural environment of the deposits is shallow, relatively stagnant water, which may at times be heated by the sun above the normal temperature of the freely circulating ocean water; the salinity of a spot sample of water from the west side of Andros Island is more than 2 parts per thousand higher than that of the normal ocean water of the region; and there is considerable organic matter in the mud.

CAUSE OF THE PRECIPITATION OF THE CALCIUM CARBONATE

In 1910 I suggested that the precipitation of $CaCO_3$ in the Florida Key region was due to loss of CO_2 because of mechanical agitation and the action of marine plants.[16]

[16] Carnegie Inst. Washington, Pub. **133**: 135. 1910.

The investigation had advanced to this stage when G. Harold Drew came to Tortugas in 1911 to study the possible effects of denitrifying bacteria on the abundance of green marine plants. He told me that he had discovered that these organisms caused the production of ammonia; and then, as the papers of Murray and other were known to me, I suggested to Drew that he perhaps had discovered the agency whereby the precipitation of calcium carbonate in the Florida Key region was effected, and he accordingly undertook a series of cultures to test the action of the denitrifying bacteria, to which he applied the name *Bacterium calcis*, without having studied the morphology of the organism.

Drew's principal paper on the subject was entitled, *On the Precipitation of Calcium Carbonate in the Sea by Marine Bacteria, and on the Action of Denitrifying Bacteria in Tropical and Temperate Seas*, in which he expressed the opinion. . . . "it can be stated with a fair degree of certainty that the very extensive chalky mud flats forming the Great Bahamas Bank and those which are found in places in the neighborhood of the Florida Keys are now being precipitated by the action of the *Bacterium calcis* on the calcium salts present in solution in sea water."[17]

Assuming that Drew's conclusions were valid, I concurred in his opinion and published such concurrence in several papers.

After Drew's unfortunate death in 1913, Messrs. K. F. Kellerman and N. R. Smith of the U. S. Department of Agriculture undertook further investigations of the bacterial floras of the Bahamian muds and their possible influence in precipitating calcium carbonate. These investigators[18] isolated Drew's *Bacterium calcis* and found that it is referable to the genus *Pseudomonas*, the name thereby becoming *Pseudomonas calcis* (Drew) Kellerman and N. R. Smith.

Kellerman and Smith recognized that the organic salts of calcium, the malate and succinate used in cultures by Drew, could not reasonably be expected to be present in significant amounts in sea-water, and, therefore, devised cultures in which the only additional supply of calcium to the sea-water was calcium sulphate contained in a suspended dialyser. The denitrifying organisms were grown in association with CO_2 producing organisms, so that the conditions

[17] Carnegie Inst. Washington, Pub. 182: 44. 1914.
[18] Journ. Wash. Acad. Sci., 4: 400–402. 1914.

would be favorable for the reaction

$$CaSO_4 + (NH_4)_2CO_3 = CaCO_3 + (NH_4)_2SO_4$$

and abundant precipitation of calcium carbonate resulted.

These experiments seemed fairly conclusive that denitrifying bacteria might be an agency in precipitating calcium carbonate in particular areas in the ocean. But Prof. C. B. Lipman, from studies he made in Samoa and later at Tortugas, Florida, reached the conclusion that denitrifying bacteria do not cause the precipitation of calcium carbonate in "pure sea water." However, as he says that "calcareous sand inoculation showed marked nitrite production,"[19] he thereby indicated that he recognized a difference between conditions in the open ocean and on the shallow sea-bottom.

In the report of the Committee on Sedimentation of the National Research Council for 1923, pp. 33–37, statements by N. R. Smith and me bring the matter as regards the Bahamian and Floridian bottom deposits up to date to April, 1923. *Pseudomonas calcis*, from present information, is principally a bottom-living organism and it seems to thrive best on a bottom in which there is considerable organic matter in the mud. The investigations are deficient in that the nature of the organic matter in the mud is still unknown, and until this deficiency is supplied satisfactory conclusions may not be expected.

There is no reason to challenge the accuracy of Professor Lipman's work or his conclusion that denitrifying bacteria do not cause the precipitation of calcium carbonate in "pure ocean water." But it seems that he has not conducted experiments under conditions which would simulate those under which the particular kind of deposit whose cause is sought is known to occur.

In May, 1922, Dr. Paul Bartsch collected an additional large sample of mud off the west side of Andros Island, Bahamas, for me, and through the kindness of Dr. K. F. Kellerman, N. R. Smith, of the Bureau of Plant Industry, undertook another study of the bacterial flora of the mud. Mr. Smith has completed an elaborate investigation and I quote from his report:

"All the colonies on three plates were picked off and put into media for pure culture work. A comprehensive and critical study of their activity showed them to belong to three large groups based upon their biochemical relations."

[19] Lipman, C. B., *Does denitrification occur in sea water?* Science, n. s. **56**: 501–503. 1922.

TABLE I.—Groups of Bacteria in B.s. 261

"Group I.		Denitrifiers.	*Ps. calcis* type.
"Group II.		Ammonifiers.	
A.	Vibrios.	Strong Ammonifier	
B.	"	Weak "	
C.	Rod-forms.	Weak Ammonifiers—Gram Negative.	
D.	"	Weak " —Gram Positive.	
"Group III.	Inactive forms".		

"The precipitation of calcium carbonate in natural and artificial sea water by mixed crude cultures from the mud and by pure cultures is given in Table III. Various sources of food for the bacteria are indicated. In each flask, a dialyzing tube containing calcium sulfate was suspended to keep a supply of calcium in solution."

TABLE II.—Calcium Carbonate Precipited in Sea Water

NUTRIENTS ADDED	INOCULUM	$CaCO_3$
(1) Peptone 0.2%; KNO_3 0.2%	Crude cultures	Many crystals
(2) " " ; " "	Group I	" "
(3) 2 gm. cooked egg albumen	Crude cultures	Crystals.
(4) 2 gm. " " "	" "	"
(5) 2 gm. " " "	Group I and II A	Many crystals
(6) Sterile mud in dialyzing tube	" I and II A	Few crystals
(7) " " " " "	Crude cultures	Very few crystals
(8) " " " " "	None	No crystals
Artificial Sea Water		
(10) Peptone 0.2%; KNO_3 0.2%	Group I	Few crystals
(11) " " ; " "	Crude cultures	Many crystals
(12) KNO_3 0.2%; " "	" "	Few crystals
(13) Peptone 0.2%; " " agar 0.2%.	Crude cultures	Many crystals and aggregates
(14) Peptone 0.2%; " " agar 0.2%.	Group I	Many crystals and aggregates
(15) Peptone 0.2%; " "	Group I and II A	Many crystals and aggregates

"One objection might be raised to the above experiments as a whole, and that is that a dialyzing tube of calcium sulfate was suspended in each flask. Also, only Group I and II-A were used for the pure culture inoculations. The following experiment therefore was set up and the results are given in Table III. Sea water with 0.02% K_2HPO_4 was used as a base, the nutrients being as indicated in the table. Plus marks indicate production of $CaCO_3$ and zero's indicate none."

TABLE III.—Inoculated by Pure Cultures of Group

Nutrients............	I	II-A	II-B	II-C	III
Peptone 0.2%.......	0	+++	0	0	0
Peptone 0.2%....... KNO_3 0 2%.........	+	+++	0	0	0

"As can be seen from a glance at the table, Group II-A in pure culture precipitated by far the greatest amount of $CaCO_3$ and Group I only precipitated $CaCO_3$ when nitrates were present. Even then the amount was comparatively small. A rough analysis of the solution in the flasks of Group II-A after the precipitation of the $CaCO_3$, showed only about half the amount of calcium of the control flask.

"From the foregoing, the following points seem to be the most important.

"1. The bacteria of sea water or bottom mud from the mud bank may be grouped into 6 main groups according to their physiological activity.

"2. Calcium carbonate is formed from calcium sulfate as a result of the growth of the bacteria; the more plentiful the food, the better is the chance for the formation of $CaCO_3$. Bottom mud provides a nutrient for the production of a small amount of $CaCO_3$.

"3. Agar in low percentage favors the formation of larger accumulations of crystals of $CaCO_3$.

"4. $CaCO_3$ is formed in natural sea water by pure cultures if organic matter is added."

These experiments show that bacteria taken from a bottom mud largely composed of chemically precipitated material will precipitate $CaCO_3$, and that the mud contains nutrient material that will support the bacteria. It also appears that the strongly ammonifying *Vibrios* are probably more important agents than the denitrifying *Pseudomonas*.

Although the researches of Mr. Smith have advanced knowledge of the possibility of the precipitation of calcium carbonate by ammonifying bacteria, other entirely inorganic factors need to be considered. Johnston and Williamson have made careful studies of the solubility-product constant $[Ca^{++}]$ $[CO_3^{=}]$, the concentration of H_2CO_3, the effect of temperature on H_2CO_3 concentration, and the relation of the solubility-product constant to rise in temperature;[20] R. C. Wells has conducted experiments on the solubility of calcite in sea-water;[21] and the relative saturation of sea-water with reference to $CaCO_3$ has been studied or discussed by a number of other investigators, including myself. The results of the different investigators are accordant, and all agree that the surface layers of the ocean water in tropical and subtropical regions is saturated or even super-saturated with reference to $CaCO_3$, and that any agency that would cause a further concentration of $CaCO_3$, or which would otherwise reduce the capacity of the water to hold $CaCO_3$ in solution, would produce pre-

[20] Johnston, J., and Williamson, E. D., *The rôle of inorganic agencies in the deposition of calcium carbonate*. Journ. Geol. **24**: 729–750. 1916.

Johnston, J., Merwin, H. E., and Williamson, E. D., *The several forms of calcium carbonate*. Amer. Journ. Sci. **41**: 473–512. 1916.

[21] Carnegie Inst. Washington, Pub. **213**: 316–318. 1917.

cipitation. Where the chemically precipitated $CaCO_3$ is known to be present, there are several such agencies. Two of them are evaporation and increased temperature, at least during the summer months. The action of green plants in reducing the CO_2 content of the water is also an important factor in certain localities. Therefore, theoretically there should be precipitation of $CaCO_3$ without any bacteria.

The different factors entering into the problems have not been evaluated and we stand now about where we did in 1916, except that advances have been made in knowledge of the physical and chemical features of the deposits and of the bacterial flora associated with them. That ammonifying bacteria, with or without the associative action of CO_2 producing bacteria, are responsible for part of the work seems reasonable. By associative action the reaction between $(NH_4)_2$ CO_3 and $CaSO_4$ may become possible. Perhaps assistance may come from a physical chemist who is an expert on equilibria or through such a physical chemist working in conjunction with a bacteriologist.

I wish to close the account of this subject by a quotation from Murray and Hjort's *Depths of the Ocean*, and a comment on their statement. They say:

"Dittmar's item $CaCO_3$, which was presumably included in order to express the fact that there is on the whole an excess of bases over acids, is obviously incomplete as it stands. From the most recent measurements we gather that a 3 per cent sodium chloride solution, in equilibrium, as regards CO_2-tension, with air (which holds good approximately for sea-water), dissolves at 25°C. about 0.07 gr. of calcium carbonate per litre. Hence there cannot be as much as 0.13 gr. per litre in sea-water [referring to Dittmar's hypothetical combinations in his analysis]. The surplus base should rather be regarded as a mixture of calcium and magnesium bicarbonates, existing in equilibrium with a certain amount of free CO_2, and of the products of their hydrolytic dissociation, viz., calcium and magnesium hydroxides. It is the two latter which impart to sea-water its alkaline reaction.

"On considering sea-water in its relation to submarine deposits we note that, of all possible combinations of cation with anion, there are three which are much less soluble than any others, and are therefore closest upon saturation and precipitation: these are calcium sulphate, calcium carbonate, and magnesium carbonate.

"From what is known of the solubility of gypsum in brines, and allowing for the excess of SO_4, one would suppose that sea-water is

very nearly saturated for this salt, and that addition of, for instance, a sulphate would precipitate it. But gypsum is unknown as a constituent of deep-sea deposits (unless of extraneous origin), so that its solubility-limit is evidently never exceeded under submarine conditions."

Although John Johnston, E. D. Williamson, and R. C. Wells have rendered valuable service in their investigation of the solubility of $CaCO_3$, we do not know the solubility limits of $CaCO_3$, $CaSO_4$, and $MgCO_3$, in the presence of one another in sea-water. Until this problem in physical chemistry has been solved, we shall not be able definitely to understand some important phenomena in the ocean. The relative solubility of the ocean salts, in the presence of one another, is one of the pressing problems of both oceanography and geology.

THE BAHAMIAN AND FLORIDIAN OOLITES

As the study of bottom deposits described to you was prompted by the desire to ascertain the origin of the oolitic rocks of Florida and the Bahamas, I will revert to them for a few moments. For some time I thought the ellipsoidal aggregates in the fine-grained muds were to be considered oolite grains, for in external features they are very similar (see plate I, figs. 1a, 1b, 2), but the grains in the mud do not exhibit the concentric structure of the oolite grains, as plate II, figs. 1–4, shows. However, the cores of the oolite grains are similar to the grains in the muds, and it may yet be shown that the muds represent a stage in the formation of the oolitic limestones. I have expressed this opinion in print, but the opinion was premature. Furthermore, I do not consider the results of my experiments on the growth of grains in the muds trustworthy.[22] The experiments were too crudely conducted.

The origin of the ellipsoidal grains is a puzzle. They resemble in size, form, and general structure, glauconite and greenalite grains, and it is probable that when their formation is explained the explanation will be of wide application. The formation of such aggregates is another of the unsolved problems of oceanography and geology.

OTHER CALCIUM CARBONATE MARINE DEPOSITS

I shall not undertake to indicate the different kinds of shoal-water calcium-carbonate deposits except to state that they are of organic

[22] Vaughan, T W, Journ Wash Acad Sci 3: 303 1913, Carnegie Inst Washington, Yearbook 12: 183 1914, Carnegie Inst Washington, Pub 182: 83. 1914.

origin, and comprise remains of algal, foraminiferal, coral, echinoid, molluscan, and other organisms. Clarke and Wheeler have made a valuable contribution to knowledge in their work on the inorganic constituents of the skeletons of marine invertebrates and calcareous algae,[23] and Goldman and Bramlette have rendered an important service in their analyses of bottom deposits to determine the percentage of the different organic constituents and correlate organic with chemical composition.

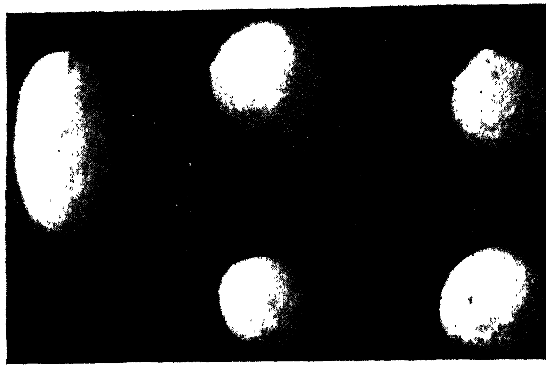
Before passing to the next topic, I wish to emphasize the fact that limestone of a high degree of purity, that is from 95 to over 99 per cent $CaCO_3$, is usually either a very shallow water or only a moderately deep-water deposit. The purest limestone is a very shallow water deposit. It is time that the erroneous statements in text-books that pure limestones are deep-water deposits should be erased. Whether a shoal-water deposit is pure limestone or not is determined not by depth of water but by outwash from the land. Where there is no outwash of siliceous, aluminous, and ferruginous material, beach deposits may contain more than 95 per cent of $CaCO_3$, and the shallow water Key West and Bahamian oolites are over 99 per cent $CaCO_3$. None of the deep-sea deposits nearly approach these deposits in purity.

COLLOIDAL CONSTITUENTS OF DEEP-SEA SEDIMENTS

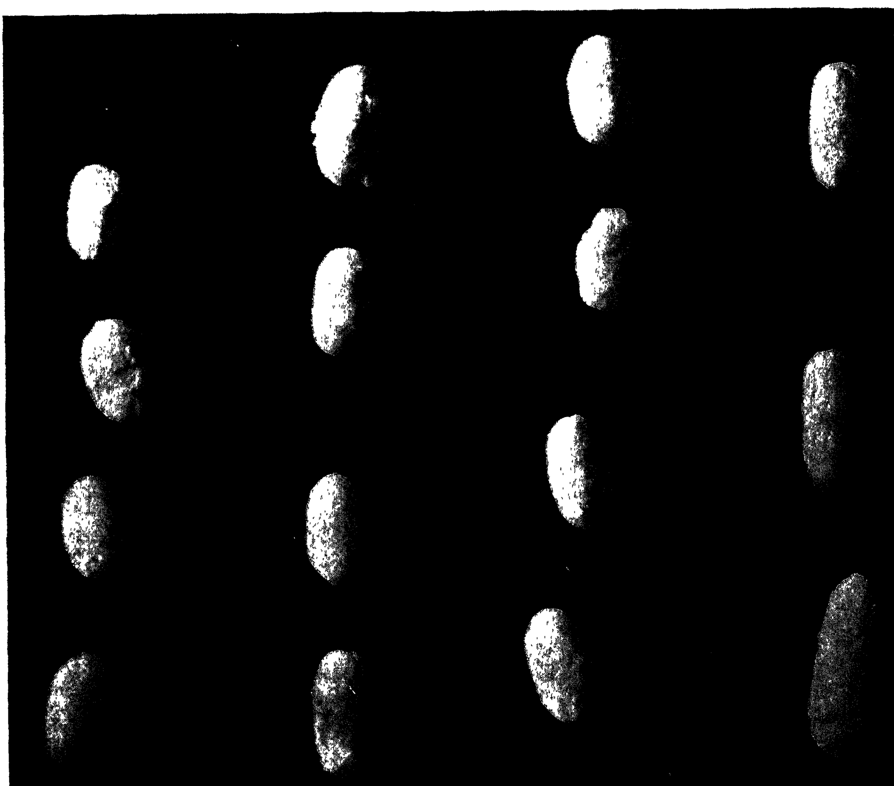
Recently chemical analyses have been made in the Chemical Laboratory of the U. S. Geological Survey by Mr. L. G. Fairchild of about 60 bottom samples collected by the U. S. Coast and Geodetic Survey Steamer "Surveyor" off the Bahamas, across the Caribbean Sea from Jamaica to Panama, and off the southwest coast of Central America to off the southern end of Lower California. These samples show, as had been pointed out by Sir John Murray, a decrease in $CaCO_3$ content with increasing depth. Prof. Milton Whitney undertook the determination of the percentage of material in the colloidal state in these samples by the amount of water vapor adsorbed, and the determinations showed that $CaCO_3$ and material in a colloidal state were reciprocal, the two percentages aggregating about 100 per cent, as is shown in the following table based on specimens of Globigerina ooze:

[23] U. S. Geol. Survey, Prof. Paper 102 (1 ed.); 124 (2 ed.) 1922.

1a X 20



1b X 20

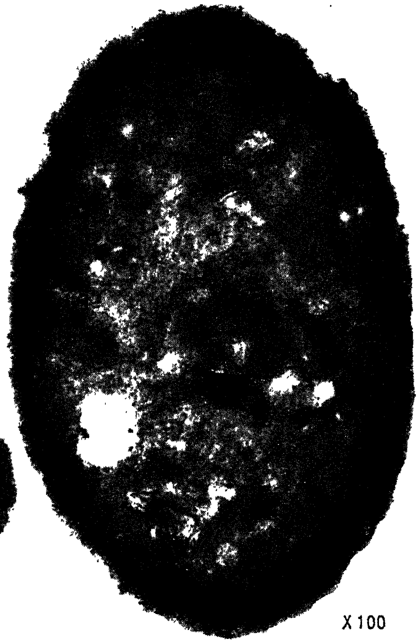


2 X 20

Figs. 1a, 1b. Oolite grains from limestone, No Name Key, Florida.
Fig. 2. Ellipsoidal grains from mud, b.s. 261, Bahamas.

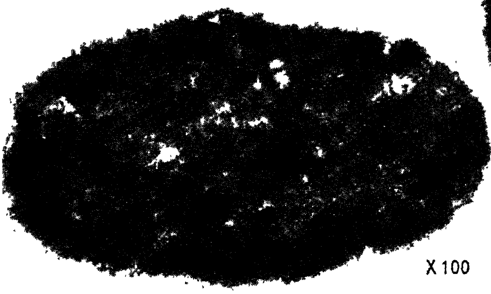
X 100

1



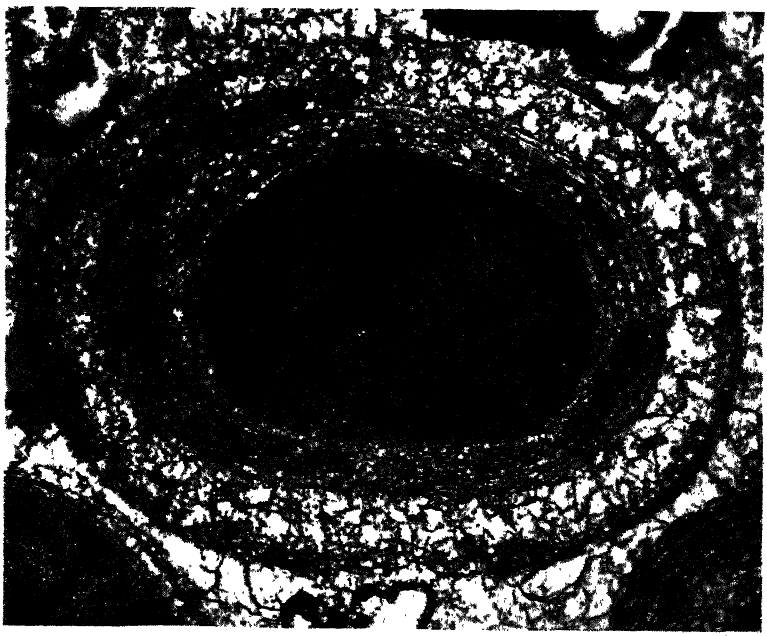
X 100

3



X 100

2



4 X 100

Figs. 1, 2, 3. Thin sections of ellipsoidal grains from muds. Figs. 1, 3, b.s. 261, Bahamas, Fig. 2, b.s. 88, Bahamas.

Fig. 4. Thin section of oolite grain, Bahamas.

NUMBER OF SAMPLE	DEPTH	TEMPERATURE °C.	$CaCO_3$*	COLLOID†
	fathoms		*per cent*	*per cent*
6	2,534	2.8	40.20	57.8
7	2,758	2.7	38.02	46.8
8	2,655	2.8	33.45	48.6
9	2,595	2.0	38.42	43.5

* Analyses by L. G. Fairchild.
† Determination by U. S. Bureau of Soils. Method used, absorption of water-vapor.

The tests reported on in the following table were based on composites supplied by Sir John Murray of all samples of red clay and blue mud collected by the "Challenger."

	PER CENT COLLOID	PER CENT NON-COLLOIDAL*	PER CENT $CaCO_3$ (STEIGER)	TOTAL
A. Red Clay............	63.3	16	8.8	88.1
B. Blue Mud............	66.5	22	9.2	97.7

* Mr. Fry reports these figures as approximations by counting a number of slides. The non-colloidal material is made up of siliceous animal remains and a few quartz fragments.

I should like to review the investigations of Prof. Sven Odén on the mechanical composition of marine sediments, but I may only state that he has made important contributions to the subject.

The analyses given above present the problem of accounting for the presence of the material in a colloidal state. There are recognizable in our present state of knowledge four possible sources of the colloid, as follows: (1) Outwash from the land; (2) volcanic and other dust precipitated from the atmosphere; (3) the residue from the tests of dead pelagic organisms after their tests have been more or less completely dissolved while falling to the bottom; (4) the mineral residue from the decomposed soft parts of organisms, some of which may be plankton and other deeper, even, bottom-living, organisms. The material is not necessarily derived exclusively from any one of these sources. It seems improbable that outwash from the continents would reach the east side of the Bahamas, but the flocculation and precipitation of particles of colloidal size in sea-water have not been sufficiently investigated to warrant a positive opinion on this possible source. Atmospheric dust, including volcanic dust, deserves careful study and attempts at quantitative estimates of its amount should be made. The test-bearing plankton, *Globigerina* and associated organisms, has not been the subject of comprehensive and detailed chemical study, and, until such studies have been made,

the nature of the residue after the solution of the $CaCO_3$ will not be known. Mr. E. G. Moberg has made chemical analyses of plankton at the Scripps Institution of the University of California, but his investigations are incomplete. He has found an appreciable amount of ash, but its composition is not yet known, or at least the results of the analyses of the ash have not been published.

The problems associated with the finer constituents of deep-sea sediments are fascinating and a number of them can be solved. I should like to discuss them further, but I may not do so on this occasion.

THE GEOLOGICAL SIGNIFICANCE OF SOME BIOLOGIC FEATURES OF THE OCEAN

Many geologic deductions are based on biologic premises. I will briefly discuss three kinds of biologic research that are needed in interpreting sedimentary rocks. These are the rate of growth of rock-forming marine organisms and the ecology and the duration of the free-swimming larval stages of marine organisms.

That marine organisms are important rock builders is known to all students of sedimentary rocks and I have in this address already enumerated the more important groups. The rate at which these agents may build rock is determined by their growth rate. About the only groups of such organisms on which there is at all adequate information are the stony corals and *Alcyonaria.* The stony corals are of more or less romantic interest because of their association with ship-wrecked mariners, feathery palms, and dusky maidens, but the volume of rock attributable to them is relatively small. The other organisms associated with reefs, the nullipores, mollusks, and foraminifera, are fully as deserving of study. If Professor Setchell should give us the data on the nullipores, as it is hoped he will, a considerable body of information will be available on three important groups of organisms in the shoal waters of the tropics. The growth rate of some economically valuable mollusks is known, and these are also rock builders, but much more information is needed. It is desirable to have observations made on the growth rate of all the organisms with hard parts at as many localities as is possible.

The organisms that transcend all others in importance as contributors to sediments are the foraminifera and I am not aware of any information on their growth rate. In fact there is probably no group of organisms on which information for geologic purposes is more greatly needed than the foraminifera. The need for chemical

analyses of the foraminiferal plankton has already been stated; and later they will be mentioned again in discussing the duration of free-swimming larval stages.

Information of the kind indicated is also needed for diatoms. Perhaps Doctor Mann will tell us uninformed geologists, how long it took to form the diatomaceous earths of the Calvert formation in Maryland and Virginia and of the Monterey group in California.

The history of most sedimentary geologic formations is in large measure deduced from premises derived through the study of the ecology of living organisms. The temperature of the seas in which ancient deposits were laid are inferred almost exclusively from biologic evidence. Depth is inferred both from organisms and the nature of the sediments. The intensity of light is inferred from depth and latitude, which controls the angle of incidence of the sun's rays. The character of the motion of the water is deduced from the physical features and arrangement of the sediments and from biologic evidence. The concentration of salts in the water is deduced from the organisms. Each one of these topics might be the subject of an essay.

We need to know for geologic purposes the ecology of all the important groups of marine organisms; and the ecology should not be considered merely in an empirical way but it should be based on the deepest ascertainable mechanical and bio-chemical foundation. Sir John Murray in his treatment of the pelagic foraminifera put before us an ideal toward which we should strive. In order to achieve the desired goal, the bio-chemistry of skeleton formation needs to be thoroughly understood, and I wish to bespeak for Dr. Shiro Tashiro all the encouragement and support his scientific colleagues can give him.

In dealing with problems of geologic correlation, which involve the consideration of the geographic distribution of organisms in past geologic time, the geologist needs to know the factors that limit distribution to restricted areas and the means whereby dispersal over a possible geographic range may be effected. I have devoted considerable attention to this topic in an address before the Paleontological Society and the Geological Society of America, and therefore, need now to treat it very briefly.

Certain fossil marine organisms attained world-wide distribution apparently in a rather short time, geologically speaking. Examples of organisms of this kind are supplied by three genera of larger foraminifera, *Discocyclina*, *Asteriacites*, and *Lepidocyclina*, which are

known in Europe, America, the East Indies, and Asia. Another genus of foraminifera, the large *Nummulites* found in the limestone of which the Egyptian pyramids are built, is not known in America, but it is known in Europe, Africa, and Asia, and as far eastward as the Bonin Islands. In the adult stage all of these organisms are bottom-living. How can such a distribution be explained? The most plausible hypothesis is that the embryos of *Nummulites* are free-swimming for only a short time and, therefore, could not be carried great distances by ocean currents, while the embryos of the other genera could be.

Several species of corals found on the east coast of Africa also occur in the Hawaiian Islands. How is so wide a distribution of corals made possible? At one stage in their life corals are free-swimming larvae and my own experiments showed that some larvae may remain free for as many as 23 days and then settle and form colonies. The long duration of the free-swimming larval stage renders possible wide dispersal by ocean currents.

In order to understand the possible distribution of organisms by marine currents it is necessary to know whether the organisms pass through a free-swimming larval stage and if they do pass through such a stage what the duration of the stage is. Unfortunately relatively little information is available on most groups of organisms. It is, therefore, obvious that one of the desiderata of geology is to know the duration of the free-swimming larval stage and the upper and lower temperature limits the larvae can withstand for just as many groups of marine organisms as is possible. I will specify foraminifera, sponges, corals, echinoderms, bryozoa, brachiopods, and mollusks.

There are other biologic features of the sea of importance to geologists, but I shall not try to enumerate more. I have mentioned three subjects on which far more research is needed before the demands of the geologists on marine biology will be satisfied.

CONCLUSION

In the remarks I have made to you, I have not attempted to outline the content of oceanography, a subject well treated in an address by Capt. R. L. Faris before the Philosophical Society of Washington and published in our Journal.[24] I should like to dwell on some other aspects of the biology of the ocean, particularly the fundamental food supply of marine organisms, and to indicate how it is a field for

[24] Faris, R. L., *Some problems of the sea.* Journ. Wash. Acad. Sci. **12**: 117–132. 1922.

investigation as yet scarcely touched, but I must pass it with bare mention. I should also like to indicate the relation of certain oceaonographic problems to problems in both geology and engineering, such as the deterioration of concrete in contact with sea-water at and near sea-level and the behavior of the finer constituents of sediments. These problems are mentioned to indicate that this address makes no claim to comprehensiveness.

The discussion of each topic considered in my remarks terminates with the presentation of a set of unsolved problems, some of them of great complexity. It might be inferred that very little is known about the ocean. Such as inference would be a half truth. If we compare what is now known with what was known in the days when Maury was doing his epoch-making work, it will be evident that great advances have been made in knowledge of the ocean. Even since the publication of Murray and Hjort's *Depths of the Ocean* in 1912, many important additions have been made to our knowledge of the ocean. We have advanced and are rapidly advancing in the science of oceanography, but our knowledge of nearly all the fundamentals is deficient. However, until knowledge had reached its present stage recognition of many of the problems was not possible. It is on the unsolved problems, particularly the more fundamental ones, that future investigations should be concentrated.

I have indicated some of the problems of oceanography and have shown that for their solution all the different branches of geophysics must lend assistance and aid must also come from those branches of geology not classified as geophysics. Oceanography in its turn can help the other earth sciences. For geology knowledge of the ocean is essential, because the ocean holds the key to the history recorded in most of the sedimentary rocks.

GEOPHYSICS.—*The distribution of iron in meteorites and in the Earth.*[1] L. H. ADAMS and H. S. WASHINGTON, Geophysical Laboratory, Carnegie Institution of Washington.

It is now generally agreed that the Earth consists of an iron core surrounded by silicate rock. The earlier speculations concerning the density at various distances from the center, it is true, proceeded on the assumptions that the Earth is essentially uniform in composition and that the high internal density is due to compression under

[1] Received June 25, 1924.

the great pressures in the interior. But, beginning with the hypothesis by Dana in 1873, the notion of an iron-cored Earth has steadily gained credence among students of the subject.

What is certainly known is this: somewhere within the Earth is a very considerable amount of material intrinsically denser than any known silicate rock. This conclusion is reached most directly from studies based on the compressibility of rocks and on the velocity with which earthquake waves are transmitted through the Earth. Such studies have yielded a *quantitative* estimate of the increase in density due to pressure at various depths and have shown that, while the effect of pressure on density is a factor not to be neglected, it is nevertheless impossible to explain the high density of the Earth on the basis of compressibility alone.[2] That is, there must be at the center some material which, under normal conditions, would be much denser than ordinary rocks.

The principal reason for assuming the dense material in the interior to be mainly metallic iron is the analogy with meteorites. Most of these visitors from outer space contain large quantities of metallic iron with varying amounts of nickel; and it does not demand an unwarranted use of the imagination to regard meteorites as fragments of disrupted bodies similar to, although probably much smaller than, our own planet,[3] and to reason that the structure and average composition of these bodies are not very different from those of the Earth.

The earlier picture of the Earth's metallic core, as presented by Wiechert,[4] was that of a central iron core separated by a rather sharp boundary from the surrounding silicate shell. More recently[5] it has been suggested that between the core and shell lies a zone of mixed metallic iron and silicate rock, called pallasite from its supposed resemblance to a certain type of meteorites. The stony shell that surrounds the iron core is supposed to be granitic near the surface, and of basic (peridotitic) character below. The probable distribution of iron within the Earth is represented by Fig. 1, which shows the central iron core surrounded by the pallasite layer,[6] above this being the silicate shell, and the outermost, thin rocky crust.

[2] Williamson, E. D., and Adams, L. H., *Density distribution in the Earth*, Journ. Wash. Acad. Sci., **13**: 413–428. 1923.

[3] Farrington, O. C., *The pre-terrestrial history of meteorites*, Journ. Geol. **9**: 626. 1901.

[4] Wiechert, E., Nachr. Ges. Wiss. Gottingen, p. 221. 1897.

[5] Williamson, E. D., and Adams, L. H., Op. cit., p. 424. Also Clarke, F. W., *The evolution and disintegration of matter*, U. S. Geol. Survey, Prof. Paper 132-D: 76. 1924.

[6] This figure is taken from Williamson and Adams, this Journal, **13**: 426. 1923.

The existence of the zone of pallasite is indicated by the course of the earthquake velocities as a function of depth. If these quantities be plotted a striking feature of the graph is that, whereas the velocity increases steadily and rectilinearly down to depths of about 1,600 kilometers below the surface, beyond this depth the velocity becomes almost constant for about 1,400 kilometers. This is accounted for by two facts based on measurements made in the laboratory: 1, the velocity increases with pressure and hence with depth; 2, the velocity is much less in metallic iron than it is in basic silicate

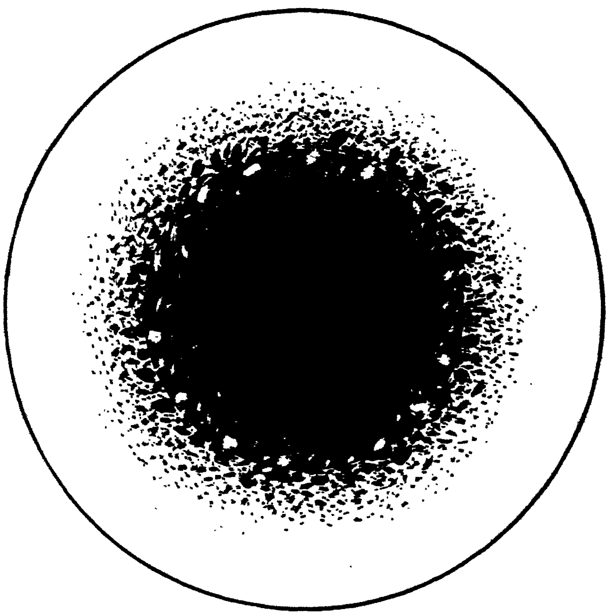


Fig. 1. Cross section of the Earth, showing supposed zone of mixed iron and silicates surrounding iron core. The width of the outer circular line represents, to scale, a surface layer 60 km. in thickness.

rock (peridotite). The small rate of change in velocity at depths below 1,600 kilometers is, therefore, explained as due to the gradually increasing amount of metallic iron mixed with the peridotite, because the normal tendency for depth to increase the velocity in the peridotite is offset by the increasing admixture of iron with a lower transmission velocity. This transition zone between the metallic core and the silicate shell may be thought of as a zone of incomplete segregation.

In view of the supposed similarity between meteorites and the interior of the Earth, it is important to consider more in detail the structure and composition of meteorites.

Meteorites are classified into three main groups: *siderites*, composed almost wholly of nickel-iron; *siderolites*, composed of about equal parts of nickel-iron and silicates, the latter chiefly olivine and orthorhombic pyroxene; and *aerolites*, composed almost wholly of silicates, also chiefly olivine and orthorhombic pyroxene. Small amounts of some non-oxide compounds (sulphides, phosphides, carbides, etc.) are almost always present, but they may be disregarded here.

The metal and the silicates appear to be immiscible and, when solidified, they may be intermingled in two ways: the silicate may

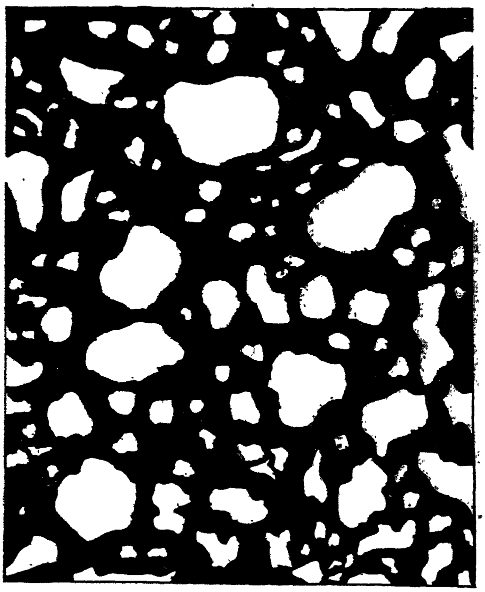


Fig. 2. Diagrammatic representation of a lithospor: silicate scattered, or sporadic, in a continuum of iron.

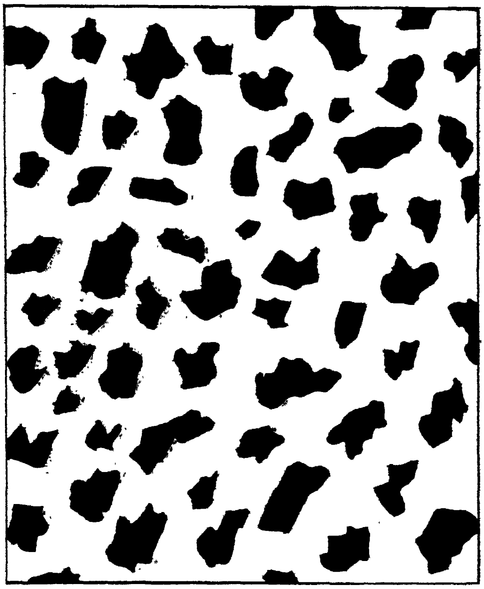


Fig. 3. Diagrammatic representation of a ferrospor: iron scattered, or sporadic, in a continuum of silicate.

be scattered sporadically through a more or less continuous mass of metal, or the metal may be scattered sporadically through a mass of silicates. The former case is illustrated diagrammatically in Fig. 2, and the latter in Fig. 3.

We propose to call the first case, that in which the silicate is sporadic in metal, *lithospor;* and the second, that in which the metal is sporadic in silicate, *ferrospor;* the adjectival forms being respectively *lithosporic* and *ferrosporic*. The material in which the sporadic particles, whether metal or silicate, are embedded would naturally be called the *continuum*.

This distinction between these two types of intermingled iron and silicate was first applied to the classification of meteorites by Daubrée[7] who suggested the terms "syssidères" for those with silicate sporadic in a continuum of iron, and "sporadosidères" for those in which the iron is sporadic in a mass of silicate. Daubrée's terms seem not to have been generally adopted, except by Daubrée's successor Meunier.[8]

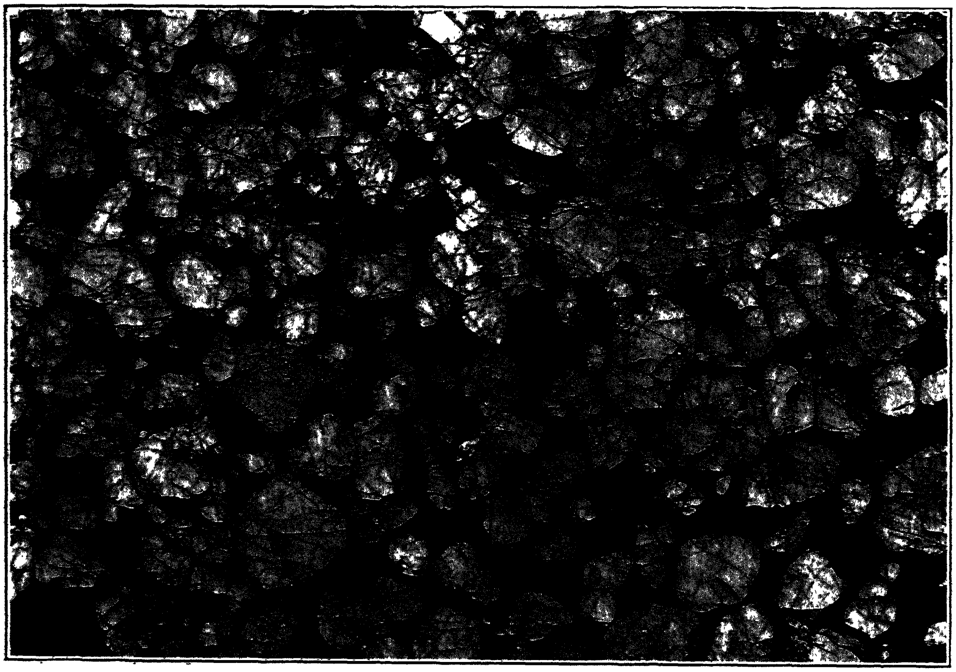


Fig. 4. Actual lithospor (meteoric). Photograph of section of Mount Vernon pallasite. The iron is shown as black.

The now generally accepted classification of Brzina takes little note of the distinction.

These are the two chief, and extreme, modes of intermingling found in meteorites. The lithosporic type is illustrated by the pallasite found at Mount Vernon, Kentucky,[9] (Fig. 4) in which rounded

[7] Daubrée, A., *Classification adoptée pour la collection des meteorites du Muséum*, Comptes Rendues **65**: 60–63. 1867.

[8] Meunier, S., Guide dans la collection des meteorites avec le catalogue des chutes representées au Muséum, Paris, 1898.

[9] We are indebted to Dr. G. P. Merrill, of the U. S. National Museum, for the photographs of specimens in the museum reproduced in Figs. 4, 5a, and 5b. Fig. 4 represents part of Fig. 28 of Merrill's Catalogue of the meteorites in the U. S. National Museum, Washington, 1916.

nodules of olivine are sporadic in a coherent, continuous "sponge" of nickel-iron.[10] This, the most common type of siderolite, is called pallasite. The silicate is usually olivine, much less commonly or-

Fig. 5a. Actual ferrospor (terrestrial). Photograph of section of iron-bearing basalt from Kaersut, West Greenland. The iron is shown as black.

Fig. 5b. Actual ferrospor (meteoric). Photograph of section of the Alfianello stony meteorite. The iron is shown as black.

thorhombic pyroxene, or both olivine and pyroxene; but the texture is almost always the same.[11] In the siderites, composed almost

[10] Tassin, W., The Mount Vernon meteorite, U. S. National Museum, Proc. **28**: 214. 1905. From measurements of the areas, Tassin estimates that the percentage of iron is about 36.5 and that of olivine, about 62; his analyses yielded the estimates, respectively, of 33 and 63. Measurements of photographs by Chirwinsky (Mineral. Abstracts, **2**: 84. 1923) gave values of about 41 per cent of iron and 59 per cent of olivene. These are percentages by weight. We estimate, by measurement of the photograph shown in Fig. 4, iron 32 per cent by volume and silicate, 68 per cent, corresponding to the weight percentages, iron, 52, and olivine, 48.

[11] In a sparsely represented sub-group of the siderolites, the "mesosiderites", the metal sponge, although continuous in the mass is separate (discontinous) in thin section: see Farrington, Meteorites, 1915, p. 201, and Merrill, Catalogue of the Meteorites in the U. S. National Museum, 1916, p. 4. This rare type constitutes a transition to the ferro-

wholly of metallic nickel-iron, the constantly present but small amounts of non-oxide minerals are, similarly, always sporadic nodules in the continuous "sponge" of metal.

The ferrosporic type is represented by two examples, shown in Figs. 5a and 5b.[12] The former shows a specimen of the iron-bearing basalt of Kaersut, West Greenland, in which the iron is of terrestrial origin, its volume percentage amounting to 31; the latter shows the stone which fell at Alfianello, near Brescia, Italy, on February 16, 1883. This meteorite contains (in round numbers) about 44 per cent (by weight) of olivine, 41 of bronzite, 8 of nickel-iron, and 7 of iron sulphide (troilite). The ferrosporic type is characteristic of most aerolites, or stony meteorites, in which the amount of metal averages about 10 per cent.

There is a difference which is more apparent than real with respect to the continuity of the material, whether metal or silicate, in which the other is scattered. In the iron-stone meteorites, the siderolites, the continuum is an apparently uninterrupted "sponge" of metal; but the metal is really made up of separate crystal individuals of several nickel-iron alloys. In the stone meteorites, the aerolites, the continuum is continuous only in the sense that it is entirely silicate, but is composed of separate crystals, grains, or fragments, of one or more different silicates.

The lithosporic pallasites contain from 35 to 75 per cent of silicate, with an average of about 50; and the ferrosporic aerolites contain from about 20 per cent of metal to almost none, the average being about 12 per cent.

The analogy with meteorites not only bears out the hypothesis that the central part of the Earth is composed of nickel-iron and a mixture of nickel-iron and silicate, but it suggests further a succession of metal-silicate textures like those shown by meteorites, distinguished by the sporadicity of either silicate or metal, as is illustrated in Figs. 2 and 3. The size of the discrete particles which make up the lithosporic and ferrosporic material of the Earth may cover a vast range—from microscopic particles to "particles" many hundreds of meters in diameter.

We may suppose, then, that in passing from the center outward the almost wholly metallic core of nickel-iron changes gradually into pallasite, with sporadic silicate. In this region the percentage

[12] Fig. 5a is part of Plate LV, in Phalen, W. C., *Notes on the rocks of Nugsuaks Peninsula and its environs, Greenland*, Smithsonian Misc. Coll. 45, 1904. Fig. 5b is from an unpublished photograph made and given to us by Dr. Merrill.

of silicate gradually increases until the pallasite merges into ferrosporic material with scattered grains of nickel-iron, analogous to the greater number of aerolites. The iron becomes less and less abundant, until at about 1,600 kilometers below the surface the material is entirely silicate rock, free from metallic iron, except for rare examples, such as the iron-bearing basalts of Disko Island and Bühl in Hesse-Cassel.[13]

The Earth, then, is to be conceived of, not as a huge meteorite, but as a body similar to those of which meteorites are but fragments representing different parts of the whole mass. On disruption, therefore the Earth would yield all of the known kinds of meteorites.

PHYSICS.—*Some recent results obtained in standardization of geodetic base line tapes.* L. V. JUDSON and B. L. PAGE, Bureau of Standards. (Communicated by G. K. Burgess.)

The standardization of invar base line tapes or wires is regarded in all countries as a process requiring not only apparatus which is most carefully designed but also a facility and care of manipulation, which is perhaps excelled in ordinary linear measurements only in the comparison or use of the national prototype meters themselves.

The equipment for the standardization of base line tapes at the Bureau of Standards is adequate for testing these tapes with a precision much higher than is yet required for their use in the field. Its present state of development—for in its origin it was essentially field apparatus—is the result of accumulated experience in this Bureau and elsewhere. It is a comparator having many merits which it is hoped may be described in a publication in the near future.

There are, however, certain results of recent standardizations of tapes which are of sufficient importance to be discussed at this time in a separate article. In a recent test of six 50-meter invar tapes for the U. S. Coast & Geodetic Survey, a standardization was made during the last week in March. As these tapes were new and as certain tapes received just previously had been found to be unstable as to length, it was decided to keep the tapes for further standardization. The latter work was done on the first of May. A day's work included for separate determinations of the lengths of the tapes

[13] Somewhat similar ideas as to a gradual change from lithosporic pallasite to ferrosporic material between the metallic core and the outer crust have been suggested by Clarke, Op. cit., p. 77, and by Chirvinsky, Op. cit., p. 84.

when supported at three points and when supported at five points. The results summarized in Table I give a fair conception of the consistency of the results obtained in this important field of standardization. The observations were made at an average temperature of 25.4°C.

TABLE I

TAPE NUMBER	CORRECTION TO TAPE WHEN SUPPORTED AT THREE POINTS			CORRECTION TO TAPE WHEN SUPPORTED AT FIVE POINTS		
	March 26th and 27th 8 Determinations	March 26th, 27th and May 1st. 12 Determinations	V	March 26th and 27th 8 Determinations	March 26th, 27th and May 1st. 12 Determinations	V
	microns	*microns*	*microns*	*microns*	*microns*	*microns*
1	−3970.0	−3969.0	1.0	−976.0	−973.4	2.6
2	−3809.5	−3814.9	6.4	−800.1	−800.7	0.6
3	−3468.4	−3472.4	4.0	−529.0	−533.6	4.6
4	−3380.6	−3380.4	0.2	−537.6	−537.7	0.1
5	−2939.1	−2939.0	0.1	−334.2	−332.6	1.6
6	−3167.5	−3163.3	4.2	−656.8	−658.9	2.1
Average......................			2.6	Average.............		1.9

That this consistency is not due to an erroneous standardization on either date being compensated by a change in the length of the tapes is indicated by the fact that a tape used in the standardization work at the Bureau for several years was also measured, and its length remained constant to about ten microns, and was entirely consistent with previous results. For this tape the values of V were 25.2μ and and 9.7μ, opposite in sign. The largeness of this quantity compared with those in the table above is easily explained by the character of the line and the general condition of the tape.

TABLE II

TAPE NUMBER	COMPUTED CORRECTIONS OF TAPE SUPPORTED THROUGHOUT			
	From observations at three supports	From observations at five supports	Mean	V
	microns	*microns*	*microns*	*microns*
1	+66	+65	+66	1
2	+252	+245	+248	3
3	+471	+480	+476	4
4	+447	+446	+446	0
5	+595	+577	+586	9
6	+202	+207	+204	3
Average..				4

There is another result which gives an insight into the relative accuracy which is obtained in the measurement of base line tapes. The correction to the length of the tape when supported throughout can be readily computed if there are known, its weight per unit length and the correction to the tape when supported at three or at five points. For the test of the six tapes already referred to, the corrections when supported throughout were found by computation, and are given in Table II.

This was not a test undertaken with unusual care, but is representative of the standardization of tapes as now being carried out at the Bureau of Standards. Table III gives these data for other tape standardizations of the past few months.

TABLE III

TAPE NUMBER	COMPUTED CORRECTIONS OF TAPE SUPPORTED THROUGHOUT			
	From observations at three supports	From observations at five supports	Mean	V
	microns	*microns*	*microns*	*microns*
7	+2932	+2897	+2914	17
8	−69	−69	−69	0
9	+1391	+1391	+1391	0
10	+1559	+1541	+1550	9
11	+454	+450	+452	2
12	+801	+805	+803	2
13	+1244	+1252	+1248	4
14	+1101	+1128	+1114	14
15	+1498	+1489	+1494	5
16	+499	+477	+488	11
Average				6

The accumulated records of the Bureau of Standards show that these standardizations determine the values not only to a high relative accuracy but also to a high absolute accuracy.

PHYSICS.—*Notes on the graduation of invar base line tapes.* L. V. JUDSON and B. L. PAGE, Bureau of Standards. (Communicated by G. K. Burgess.)

The precision required in modern geodetic measurements necessitates that the lines ruled on tapes be smooth and even, perpendicular to the edge, clearly visible to the naked eye, and yet not deep enough to affect the strength of the tape. Lines have recently been ruled on geodetic tapes with a result which appears to be so satis-

factory that a brief description of the method illustrated by a photograph (×10) (Fig. 1) of one of them may prove of interest. The lines, 20 microns wide, ruled with a special diamond, carefully set to ensure a single, even, symmetrical line were graduated directly on the invar tape after a small section of the tape had been polished. Owing to various characteristics of invar tapes it is found difficult by the use of the ordinary methods to obtain a good line at the edge

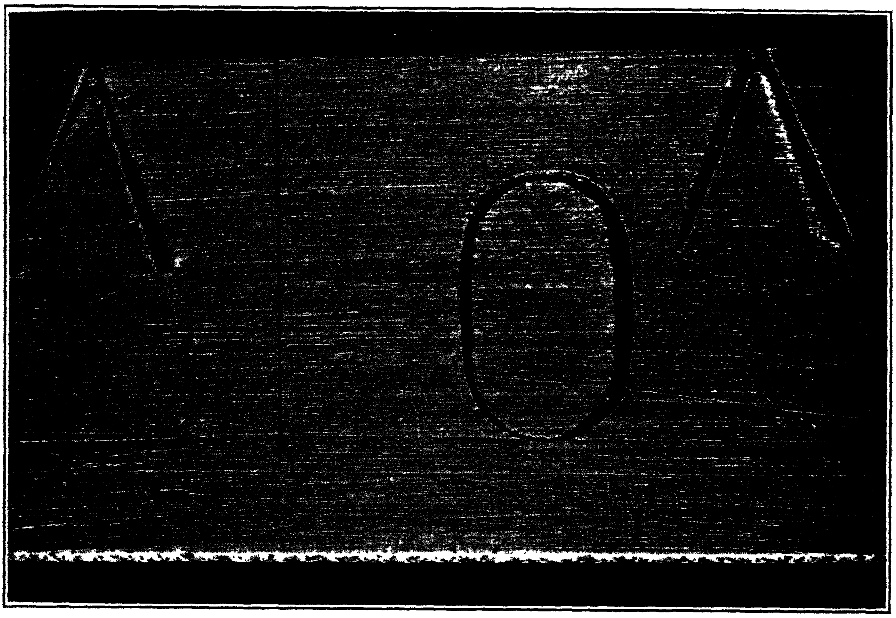


Fig. 1. Photograph of ruling on tape. Magnified 10 diameters.

of the tape. This difficulty has been overcome, however, by filing off the edge of the tape, after the lines had been ruled. A specially constructed template was used in order to take off a very small amount and yet enough to cut off the broadened end of the line. The edge of the tape used in measurements is then smooth, and perpendicular both to the surface of the tape and to the line.

BOTANY.—*A new species of* Panicum *found in alfalfa seed.*

AGNES CHASE, Department of Agriculture.

In the course of his work in seed investigation Mr. F. H. Hillman of the U. S. Department of Agriculture found Panicum seeds [fruits] in samples of alfalfa seed from the middle western states that did

not agree with those of any species described and figured in the *Revision of Panicum* by Hitchcock & Chase.[1] The fruits and the spikelets found indicated some species of the *Capillaria* group, though the pronounced scar at the base of the fruit suggested *P. filipes* Scribn., of the allied perennial group *Diffusa*. Mr. Hillman and the writer examined all likely species in the Grass Herbarium without finding the fruits sought. The spikelets resembled most closely those of *Panicum barbipulvinatum* Nash, so Mr. Hillman began a systematic examination of specimens of this species from the Middle West and found the fruit with the pronounced basal scar in a plant from Bucklin, Kansas, collected by A. S. Hitchcock in 1892. After that the writer examined all the rest of the material referred to *P. barbipulvinatum* and found six more plants. The seven resemble each other closely, and differ from typical *P. barbipulvinatum* in that they do not have short flowering branches from the base. *Panicum barbipulvinatum*, however (even with these seven segregated from it) is so variable in habit that these seven could not be excluded on their general appearance alone. They differ chiefly in the stouter culms, firmer foliage, stiffer panicle branches with the lateral spikelets on shorter more appressed pedicels, in the well-developed sterile palea, and especially in the larger darker fruit, with a prominent lunate scar at the base.

The discovery of a hitherto unrecognized species by its seed emphasizes the taxonomic value of seed characters. It also goes to show that the differentiation of closely allied species, instead of being of "no practical value," as is sometimes alleged, may be of great importance in applied botany. The eight native species of the *Capillaria* recognized in the Revision, together with *P. tuckermanii* Fern.[2] (the New England form included in *P. philadelphicum* Bernh. in the Revision) and the species discovered by Mr. Hillman, are so closely interrelated that we have sometimes been doubtful whether they are really distinct. *Panicum barbipulvinatum*, in particular, we have regarded as doubtfully distinct from *P. capillare*. Yet in his work Mr. Hillman recognizes this species from the size and shape of its seed, and also an additional form we failed to distinguish.

The mature spikelets and fruits, as found in alfalfa seed, are plumper than those of herbarium specimens. Species of Panicum drop their fruits so readily that in collecting plants with fully mature seed most of the spikelets are lost. In a forthcoming paper by F. H. Hillman

[1] Contr. U. S. Nat. Herb. **15**. 1910.
[2] Rhodora **21**: 112. 1919.

and Helen H. Henry on *Incidental seeds found in alfalfa and red clover* (to be published by the U. S. Department of Agriculture) the spikelets and ripe fruits of the species of the Capillaria group are figured from several view points, showing differences in contour.

Panicum hillmani sp. nov. Plants annual, in tufts of 1 to 6 flowering and 1 to 3 or 4 sterile culms, 18 to 35 cm. tall, erect or recumbent at base, the lower nodes geniculate; culm papillose-pilose below the panicle and below the nodes, otherwise glabrous; sheaths mostly longer than the internodes, papillose-hispid; ligule membranaceous-ciliate, about 2 mm. long; blades erect or slightly spreading, firmer in texture than common in those of *P. barbipulvinatum*, 7 to 13 cm. long, 3 to 10 mm. wide, papillose-hispid beneath, pilose, sometimes sparsely so, on the upper surface; panicle short-exserted at maturity, 10 to 17 cm. long, as broad or broader, less than half the entire length of the plant, the main axis pilose, the prominent pulvini hispid, the branches stiffly spreading, mostly pilose toward the base, the secondary branches spreading at a narrow angle, the ultimate branchlets and pedicels appressed, scabrous; spikelets reddish or brownish at maturity, 2.5 to 3 mm. long, 1 mm. wide, turgid, acuminate; first glume about two-fifths the length of the spikelet, pointed, 3 to 5-nerved, the midnerve minutely scabrous toward the apex; second glume and sterile lemma equal, much exceeding the fruit, 7 to 9-nerved, the nerves minutely scabrous toward the apex, the hyaline sterile palea more than half as long as its lemma; fruit at maturity olivaceous drab, 2 mm. long, 1 mm. wide, elliptic, with a prominent slightly raised lunate scar at the base. (Figure 1).

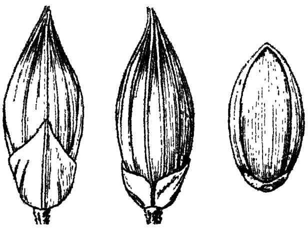


Fig. 1. Panicum hillmani, two views of spikelet and fruit.

Type in the U. S. National Herbarium no. 1,037,542, collected on "plain, Amarillo, Texas, August 11, 1918" by A. S. Hitchcock (no. 16206).

Distribution: Prairies and plains Kansas to Texas.

KANSAS: Bucklin, *Hitchcock* in 1892; Ulysses, *Thompson* 56.

OKLAHOMA: "Washita or Swanson Co." *Stevens* 1197.

TEXAS: Big Spring, *Hitchcock* 13367; Amarillo, *Hitchcock* 16206; Abilene, *Tracy* 8295; Without locality, *Nealley* in 1889.

Received April 18, 1924.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

899th MEETING

The 899th meeting was held in the Cosmos Club Auditorium, March 22, 1924. It was called to order by President HAZARD with 40 persons present.

Program: CHARLES MOON: *Electrically controlled micrometers.* The paper was illustrated with lantern slides.

The instrument described in this communication was designed for measuring the diameters of cylinders which are to be used as forms for precision inductance standards. The instrument is equipped with electrical control so that it can be placed with the cylinder to be measured in a constant temperature cabinet and measurements taken without opening the cabinet. The essential parts of the micrometer are: (1) a rigid frame; (2) a measuring screw actuated by a tiny electrical motor with reduction gearing; (3) a pressure indicating device which automatically stops the motor when the measuring pressure reaches a critical value.

The frame of the instrument is a heavy iron ring 40 cm. in diameter made from a well aged casting. Great constancy in the diameter of the ring is not necessary because frequent reference can be made to an end standard.

Measuring screw, motor, and reduction gearing: an ordinary metric micrometer head by Slocumb is used as a measuring screw. The index circle is 15 centimeters in diameter and is graduated in 500 parts each representing one micron. The errors of the screw are small and known. A small D.C. motor was built for the drive. The armature is 15 mm. in diameter and weighs 6.2 grams. The gear train from a small alarm clock gives a reduction in speed from 30,000 to 1.

Pressure indicating device: the end of a hardened rod in a steel tube is used as a measuring point opposite the screw. The measuring pressure is determined by the compression of a spring fitted between the rod and tube. When the pressure reaches a definite value the back end of the rod comes into contact with a lever and opens a pair of platinum contacts in the armature circuit.

Tests made with the micrometer show that it is capable of as high precision as can be obtained by hand operated screws with the advantage of remote control. In a series of 30 readings on a 300 mm. end standard the greatest deviation from the mean is 0.1 micron. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. Heyl, Eckhardt, Pawling, Gish, Priest, and Hawkesworth.

O. S. Peters: *New developments in electric telemeters.* The paper was illustrated with lantern slides.

Development work has been in progress for several years at the Bureau of Standards on an electrical telemetric device suitable for measuring strains, displacements, forces, and accelerations, of either steady or rapidly varying value, at a distance. Satisfactory progress has been made and apparatus developed of sufficient accuracy and stability for many kinds of engineering measurements. For its operation this device depends upon the displacement-resistance characteristic, or corresponding pressure-resistance characteristic of a series of carbon contacts. The carbon contacts were selected in preference to other means and substances after extensive tests, and after mounting for the carbon had been devised that gave accurate and dependable calibration and sufficient stability to withstand the shocks due to ordinary handling.

Practical applications so far made consist of the following:

1. Measurement of loads in airplane stay cables during flight.
2. Measurement of strains in airship girders during flight and also in laboratory tests and during construction.
3. Tests of bridge members due to live loading.
4. Tests of bridge members in the laboratory.
5. Measurement of pull on the pressure arm of a dynamometer.
6. Measurement of pressures.

The chief advantages obtained over instruments heretofore available for similar purposes are that simultaneous records or readings can be made of strains, forces, and pressures occurring at a number of widely separated points, and that rapidly varying values can be photographically recorded in their true proportions. Measurements can also be made in places that are inaccessible during tests.

With the strain gage type of instrument records of vibratory strains have been made having harmonic frequencies superimposed as great as 570 cycles per second, with the wave shape accurately reproduced and without greater exaggeration of the deflections due to the harmonic than would arise from the characteristic of the recording element. The carbon contacts themselves have been shown to reproduce vibratory strains up to 840 cycles per second. Further research work will be required to find the upper limit of frequency at which reproduction ceases to be accurate, but that just indicated is as great as is likely to be encountered in structural members. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. PRIEST and GISH.

L. H. ADAMS presented an informal communication, *Calculation of temperature on the thermodynamic scale.*

Thermodynamic temperatures are usually determined by calculating the differences between this scale and the constant-volume or the constant-pressure gas-thermometer scale. This is usually a tedious process; but by graphical integration of a convenient form of equation, the necessary corrections can be calculated with very little effort. (*Author's abstract.*)

P. R. HEYL presented an informal communication. *The history of the determination of the newtonian constant of gravitation.*

A most remarkable instance of the influence of the personal element in scientific work is found in the work of Boys and Braun on the constant of gravitation. Boys worked with the best facilities to be found in London and Oxford University, and obtained a value which he believed trustworthy to 4 figures. No previous experimenters had ever agreed with each other in the second figure. Braun, a man of 80 years of age, a former teacher of physics, retired from service on account of advanced years and physical infirmities, worked in his cell in a monastery in the mountains of Bohemia, and obtained a value agreeing with that of Boys to 4 figures. (*Author's abstract.*)

Discussion. The paper was discssed by Messrs. GISH and PAWLING.

900TH MEETING

The 900th meeting was held at the Cosmos Club, April 5, 1924. The meeting was called to order by President HAZARD, with 45 persons present.

Program: FRANCIS A. TONDORF, S.J., Georgetown University: *The seismogram and its interpretation.* The address was illustrated with lantern slides, and a number of original seismograms were exhibited.

No seismogram is a contribution to the literature of geophysics unless the data which may be deciphered therein can be expressed in absolute units. Such data are not available from grams of unstandardized seismographs. Standardization, therefore, of these instruments by a competent authority, internationally recognized, is a desideratum and would give to our grams an imprimatur for their use in international researches. A one-man interpretation of the registrations of the vibrations of the earth is very unreliable if not worthless. A comparative analysis of grams of the same quake as registered at different observatories, made by a committee of experienced seismologists, would offer material worth the while. Under such a committee

ambiguities in grams occasioned by the superposition on grams of markings not of seismic origin, could be lifted.

It is suggested that such scientific corporations as the National Research Council, the Geophysical Union, or the Carnegie Institution, and the like, inaugurate the above movement. Such would tend to a reorganization of the 35 or more seismic observatories of the United States, now mostly inactive, encourage the founding of new observatories, and materially unravel the mysteries which lurk within the earth's crust. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. W. BOWIE, HUMPHREYS, HAWKESWORTH, L. H. ADAMS, LAMBERT, and HAZARD.

901ST MEETING

The 901st meeting was held jointly with the Geological Society, at the Cosmos Club, April 19, 1924. The meeting was called to order by President HAZARD with 45 in attendance.

Program: Prof. W. M. DAVIS, Harvard University: *Oceanic problems related to coral reefs.* The address was illustrated with maps and diagrams.

Oceanic problems are numerous and varied. They may be divided into two groups according as they deal chiefly with observable phenomena, or chiefly with theories about observable phenomena; but it should be understood that, in problems of both groups, the main object of study is a search for *facts:* not less so in the group of theoretical problems where the facts have to be recovered from the unobservable geological past by the mental process of logical inference, that in the group which deals with present-day facts, directly observable.

Among the theoretical problems, some are highly speculative; for example, those dealing with the development and the behavior of the ocean floor. Speculation on that problem leads to a comparison between the ocean floor and continental surfaces. If the form of both had been produced only by diastrophism, they would surely be much more uneven than they are now; but as erosion, abrasion, and sedimentation are also operative, the greater part of the continents, even though traversed by various ancient mountain systems once of great height, have been worn down to moderate altitudes, and only the youngest mountains are lofty. Similarly, the greater part of the ocean floor seems to have been aggraded to a relatively smooth surface, even though parts of it may have been formerly deepened in troughs of depression; only the recently depressed troughs are still of great depth.

That the ocean floor is not stable is indicated by the features of mid-ocean volcanic islands; for according as the floor is stable, rising or sinking, the islands, acted on by stream erosion and wave abrasion, will exhibit different forms. Several lines of evidence thus lead to the belief that mid-oceanic volcanic islands as a rule slowly subside.

The sedimentary deposits with which the ocean floor is aggraded come largely from the continents, but also in part from volcanoes. The insoluble waste of the continents is deposited near their coasts in the form of shallow shelves; and here the process of aggradation works with reference to sea-level. Much of the soluble waste, chiefly limestone, is withdrawn from solution by minute, floating pelagic organisms to make their shells, which after the death of their occupants sink to the bottom; and this process of aggradation may be said to work with reference to the average depth of the bottom. But another part of the soluble continental waste goes to form shallow banks with respect to normal sea-level around the mid-ocean volcanic islands of the warmer seas in the form of coral reefs and their lagoon deposits.

Just as the forms produced by erosion and abrasion on volcanic islands in the cooler seas, where coral reefs are wanting, may be used as the basis of inferences as to the movements of the islands and therefore also of the ocean floor from which they rise, so the forms of islands produced in association with coral reefs may be used in similar inferences; and confirmation is thus found for the opinion above expressed that most volcanic islands slowly subside, and hence that the reefs which they bear have been formed according to Darwin's theory of up-growing reefs on subsiding foundations. Only in a relatively narrow marginal belt of the coral seas is evidence found to support the belief that Preglacial reefs have been cut away by the waves of the lowered and chilled ocean of the Glacial epochs; and even there the islands around which the Preglacial reefs were built appear to have subsided during the building.

More direct evidence of the subsidence of a volcanic island during the formation of an atoll above it is found in the case of Antigua, in the Lesser Antilles. This island is believed to represent a tilted-up and beveled-off atoll, in which the basal volcanic rocks now laid bare appear to be of subaerial or shallow-water origin, and in which the covering strata, including several thousand feet of tuffs interbedded with shallow-water limestones, fresh-water cherts, and a heavy series of limestones and marls again of shallow-water deposition, testify conclusively to a progressive subsidence of the volcanic foundation during their accumulation. The thickness of strata thus exposed to examination is about five times as great as the depth of the Royal-Society boring in the Funafuti atoll reef in the central Pacific. A better example of an atoll formed according to Darwin's theory and then tilted up and beveled off for examination could hardly be imagined. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. HAWKESWORTH, BOWIE, PAWLING, MARMER, HECK and others.

902D MEETING

The 902d meeting was held at the Cosmos Club, May 3, 1924. The meeting was called to order by President HAZARD with 60 persons present.

Program: N. H. HECK and J. H. SERVICE. *The velocity of sound in sea water.* (Illustrated with lantern slides.)

The paper is the result of the sound-ranging work of the Coast and Geodetic Survey Steamer "Guide" during the oceanographic cruise between New London, Connecticut, and San Diego, California, in which both authors participated, the former having general supervision of the sound-ranging work.

The use of acoustic methods in hydrography is the result of further development and application of the apparatus developed during the war for anti-submarine work.

The cruise of the "Guide," which lasted 40 days, included the development of Vares Deep, north of Porto Rico, and a hitherto unexplored deep off the coast of Central America and Mexico. During the cruise sonic soundings were taken at frequent intervals, and in numerous cases simultaneous determinations of depth by wire and sonic methods were made, special care being used in both classes of observations.

A study of the results obtained in all depths from 185 to 4617 fathoms and the determination of velocity along the surface as reported by various organizations afforded the basis for developing a practical method of obtaining the theoretical velocity of sound in sea water. This was based in part on the results of the Challenger Expedition and on the results of Ekman as pointed

out by Dr. George McEwen, Scripps Institution, La Jolla, California, who gave valuable assistance and advice. It was shown by Newton's Law

$V = \sqrt{\frac{\text{elasticity}}{\text{density}}}$ can be put in the simple form,

$V = 10^3 v \sqrt{\frac{10}{10^5 dv}}$ where V is the velocity in meters per second, v is the specific volume from Bjerknes' tables for a given condition and dv is the change in specific volume per bar change in pressure as given in the fifth place of the Bjerknes specific volume tables. For any given sounding the velocities are computed for 200 fathom layers and then the mean velocity is considered to be that of the sounding.

The agreement of this formula with known horizontal velocities was shown to be very close. The following agreement was shown in the case of soundings where the physical conditions were determined by the "guide" or were otherwise known. Agreement for depth 2171 fathoms in the Pacific = 0.3 per cent; agreement for 5 soundings near 3000 fathoms in Atlantic = 0.7 per cent; agreement for 3 soundings, 4000 to 4600 fathoms in the Atlantic = 0.9 per cent. Twenty-three soundings in the Pacific, selected without regard to bottom conditions, when computed in part by physical observations of the "Guide" and in part by data obtained from German publications, gave a mean difference between the theoretical and measured velocities of nearly zero. Thirty-eight soundings along the coast near San Diego, with all kinds of bottom conditions gave similar results.

The conclusion is that the theory affords a working basis for determining the velocity of sound from known physical conditions and also shows that in most cases the bottom slope is not great enough to seriously affect the soundings.

It was shown that steep slopes while important geographically and of special interest to the geologist, cover comparatively small horizontal areas as compared with the great extent of the flat areas. Slope determination in sonic work may therefore be considered a special problem. A list of possible sources of error was given.

A program for future development and application of the method was indicated and its strength and weakness was analyzed. The need of physical observations in future surveys was pointed out. It was recommended that all future oceanographic expeditions use the sonic method to the fullest possible extent but that actual velocities of sound be used, and simultaneous wire and sonic soundings be taken at reasonable intervals. The authors are planning to extend this paper and prepare it for publication by the Government to be used for future sonic and radio acoustic work. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. L. H. Adams, Hawkesworth, Humphreys, Stephenson, W. M. Davis, Parker, Gish, Littlehales, Eckhardt, Hayes, Lawson, and others.

A method of radio acoustic position determination was presented by E. A. Eckhardt and M. Keiser. (Illnstrated with lantern slides.)

This method was developed for the use of and in cooperation with the U. S. Coast and Geodetic Survey.

The position of a ship in coastal waters is determined by measuring its distance from several shore stations at known map points. These distances are obtained by measuring the times in which a sound signal travels through the sea water from the ship to the receiving hydrophones of the shore stations. In practice the sound signal is provided by firing a small bomb at a suitable

depth. The time of firing the bomb is recorded on a chronograph aboard ship. The sound upon its arrival at the shore station hydrophone automatically starts a clock-work mechanism which sends out several radio signals at definite intervals. These are also received and recorded on the chronograph aboard the ship. Other shore stations operate similarly except that the clock-work mechanism staggers the signals so as to minimize the danger of simultaneous arrival and resulting confusion. The shore station apparatus is so designed that by throwing a single switch the station may either be operated by sound via hydrophone or by radio via antenna and radio receiving set. When operated by radio all shore stations are started simultaneously, since the transmission time of the radio signal is small enough to be ignored, and the record on the ship contains the time at which the tripping signal was sent from the ship and the times at which the shore station signals arrived. The intervals read from the chronograph charts therefore give the lags. The time intervals obtained on firing the bomb corrected by these lags give the travel time of the sound. These times multiplied by the sound velocity give the corresponding distances. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. LAWSON, HECK, HUMPHREYS, and HAZARD.

903D MEETING

The 903d meeting was held at the Cosmos Club Saturday, May 17, 1924. The meeting was called to order by President HAZARD with 35 persons present.

Program: LOUIS A. BAUER. *Correlations between solar activity and atmospheric electricity.* (Illustrated with lantern slides.)

It has been known for many years that certain fluctuations of the Earth's magnetic field vary appreciably with sun-spots. The first one to have raised the question whether atmospheric electricity also might be subject to a sun-spot cycle variation appears to have been Dr. A. Wislizenus, a physician of St. Louis, Missouri, who for 12 years, 1861–1872, made relative measurements of the atmospheric potential-gradient six times daily. As this question is conceded to be of paramount importance in theories of the origin and maintenance of the Earth's negative electric charge, it was thought well worth while to make a preliminary examination of the available atmospheric-electric data, especially those obtained since the method of absolute measurements of the potential gradient was introduced. In view of the many disturbances to which atmospheric-electric results are subject, it was necessary to restrict the investigation to the so-called electrically undisturbed days; these are "fine weather days," or days of no negative potential and no pronounced electric disturbances. The chief conclusions reached at present as based upon observatories where atmospheric-electric data have been obtained for a sun-spot cycle, or longer, are as follows:

1. During the past two sun-spot cycles (1901–1923), the atmospheric potential-gradient and the amplitudes of the diurnal variation and of the annual variation generally increased with increased sun-spot frequency; the increase in the particular electric element considered was about 20 to 25 per cent, on the average, for a change of 100 in the sun-spot number. The correlation coefficient, on the average, was about 0.75.

2. If any reliance may be placed on the very few available series of atmospheric-electric observations, made prior to 1901, hence before the period of absolute observations, then there are some indications that during two pe-

riods, centering about 1855 and 1889, the reversed relationship mentioned in (1) applied. The forthcoming sun-spot cycle will afford opportunity to examine into this matter more thoroughly.

3. An interesting correlation is exhibited by the atmospheric-electric and magnetic data for 1893, which unite in showing a decrease in the electric and in the magnetic activity at the time of maximum sun-spot frequency.

4. There is some indication that highly disturbed days in atmospheric electricity may in general correspond with highly disturbed days in terrestrial magnetism. Interesting correlations are, in fact, found between certain phenomena of terrestrial magnetism, earth currents, and atmospheric electricity that probably must be referred as a joint cause to solar activity.

In view of the theoretical bearings of the questions raised and their general interest, it is very much hoped that the present results will stimulate those in charge of atmospheric electric stations to use all possible care to ensure continuity of strictly comparable data for as long a period as possible. (For fuller publication see June, 1923 issue of the Journal of Terrestrial Magnetism and Atmospheric Electricity.) (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. MAUCHLEY, PAWLING, HAWKESWORTH, HUMPHREYS, and GISH.

S. P. FERGUSSON and R. N. COVERT. *The new standard anemometer* (presented by Mr. Fergusson). (Illustrated with lantern slides and the old and the new standard anemometers were exhibited.)

The investigation described before the Society on December 16, 1922, has reached a stage where announcement can be made of corrections for velocities indicated by the Robinson anemometer used as a standard in America during the past 70 years and of a design for a new instrument, more accurate, rather better structurally, and adaptable to a larger range of uses. The new anemometer is of the three-cup type suggested in 1921 by Dr. J. Patterson of the Canadian Meteorological Office, with whom the dimensions and proportions were discussed, in order that the same standard of measurement might be adopted in the United States and Canada. The rate of the new anemometer is more nearly constant than that of the old and its maximum error does not exceed 5 per cent. It is expected that the new standard will be placed in service as soon as apparatus now in use can be altered or replaced. The change of standard will not bring about conspicuous changes in records of average velocities below 5 meters a second, but a revision of normals for higher velocities and of standards for destructive winds or gales (which as now recorded are 10 to 22 per cent too high) will be necessary. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. PAWLING, BAUER and HUMPHREYS.

904TH MEETING

The 904th meeting was held at the Cosmos Club, May 31, 1924. The meeting was called to order by President HAZARD with 44 persons present.

Program: ALFRED J. LOTKA, Johns Hopkins University. *Irreversibility—cosmic and microcosmic.* (Illustrated with lantern slides.)

From the standpoint of statistical mechanics the irreversibility of such processes as temperature equalization by simple heat conduction (always from places of higher to those of lower temperature) is, in a sense, only apparent. A flow of heat (by simple conduction) in the opposite direction is, from this standpoint, not impossible, but only extremely improbable. Two model

processes have been described elsewhere by the author which help to present in realistic manner and in full view to the eye the pertinent facts and relations.

Such models have the further advantage that they draw our attention to a somewhat neglected fact, namely, that a species of irreversibility very like that contemplated in thermodynamics plays an important role also in large scale processes; that irreversibility is a real relative thing—is due to restrictions placed naturally (by physical or economic constraints), or arbitrarily, upon the operations permitted. Just as the trisection of an angle is or is not an impossible feat, according as we prohibit or allow the use of instruments other than ruler and compass, so a process may be described as irreversible (in a larger sense) or not, according as we are restricted (by physical or economic constraints) to operations in bulk, or are allowed to operate separately upon individual elements.

Whereas, in the world of molecules, the Maxwell Demon, able to handle individual particles, is a mythological creature, in the world of baseball dimension, say, *we are* all Maxwell Demons, of somewhat varied dexterity. In approaching the study of the field thus opened to our view, the investigation of the course of evolution in a system comprising living organisms, we shall need to haul the Maxwell Demon from his obscure corner in the museum of scientific freaks, out into the limelight at the center of the stage. It is not a matter of impertinent academic speculation what a mythical Maxwell Demon *might* do in a world of molecules, but on the contrary it is a matter most pertinent to the business of life to investigate what actually *does* happen to a multitudinous population of Maxwell Demons of graded discriminating powers, who are thrown together in cut-throat competition in this very real world in which our lot is cast.

A more extended discussion of some of the questions thus raised will be found in the author's forthcoming book "Elements of Physical Biology." (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. HEYL, HAWKESWORTH, TUCKERMAN, and L. H. ADAMS.

J. P. AULT, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

New chairmen of divisions in the National Research Council, who assumed office in July are: Division of Chemistry and Chemical Technology, Prof. JAMES F. NORRIS of Massachusetts Institute of Technology; Division of Physics, Prof. JOSEPH S. AMES of Johns Hopkins University; Division of Geology, Dr. C. DAVID WHITE of the U. S. Geological Survey.

Dr. E. T. ALLEN of the Geophysical Laboratory, Carnegie Institution of Washington, is spending the summer months in a study of the fumarole region known as "The Geysers," Sonoma County, California.

The Director of the U. S. Geological Survey represented the Secretary of the Interior at the World Power Conference, held in London, June 28 to July 12. The Geological Survey was represented at the conference by JOHN C. HOYT.

GEORGE C. MARTIN, geologist in the Alaskan Branch of the Geological Survey, resigned July 1.

Dr. Robert Simpson Woodward, ex-president of the Carnegie Institution of Washington, died at his home on June 29, 1924, in his 75th year. Dr. Woodward was born at Rochester, Michigan, July 21, 1849. Following his education as a civil engineer at the University of Michigan, he served with the U. S. Lake Survey, the Transit of Venus Commission of 1882, the U. S. Geological Survey, and finally the U. S. Coast and Geodetic Survey. Leaving the Federal service in 1893, he became professor of mechanics and mathematical physics at Columbia University, New York City. In 1905 he succeeded the late Daniel Coit Gilman as president of the Carnegie Institution of Washington, then but recently founded by Andrew Carnegie. Dr. Gilman's term of office as its first president had been very short, and the real responsibility for formulating the working plans for the development of a new and comparatively untried form of research institution fell upon Dr. Woodward. Following fifteen years of successful administration in this office he retired from active duty in January, 1921. He was a member and ex-president of the Academy and of the Philosophical Society of Washington, having also been president of the American Association for the Advancement of Science and of the American Mathematical Society, and a member of the National Academy and other national organizations. He was the author of many contributions in mathematical physics and astronomy, especially as applied to geodesy and geophysics.

James Bowen Baylor, formerly hydrographic and geodetic engineer of the U. S. Coast and Geodetic Survey, died on May 23 in his 75th year. He was one of the oldest officers of the Survey and one of the few survivors of the cadets of the Virginia Military Institute who fought at the battle of Newmarket. He entered the Coast Survey in 1873 and as an engineer he was intrusted with numerous important missions, among them being the resurvey of the boundary between the United States and Canada. In 1902, he was appointed commissioner by the Supreme Court to trace the boundary between Virginia and Tennessee. He also undertook similar work with respect to Pennsylvania and New York.

John L. Baer, acting curator of American Archeology, Smithsonian Institution and a member of the Academy, died about May 28 in the Darien peninsula while a member of the Marsh expedition exploring this part of the Republic of Panama. He was a graduate of Lafayette College and had been a member of the Smithsonian Institution for about three years. His death was caused by a fever contracted in the region.

Clarence L. Meisinger, meteorologist with the U. S. Weather Bureau and a member of the Academy, was killed on June 2, when a balloon in which he, with Lieut. J. T. Neely, U. S. A., was conducting observations, caught fire and exploded. He was a graduate of the University of Nebraska and had been a member of the Weather Bureau since 1919.

The U. S. National Museum has received from the National Geographic Society about 1600 well-preserved bird skins, mostly collected in the high mountains of Yunan and western Szechuen provinces, China, by J. C. Rock. The collection contains many birds and several genera new to the national collection and is one of the largest and finest collections ever brought to America from China.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 SEPTEMBER 19, 1924 No. 15

GEODESY.—*On the size of the block of the earth's crust which may be independently in isostatic equilibrium.* WILLIAM BOWIE, U. S. Coast and Geodetic Survey.

As investigations in the theory of isostasy progress, we are better able to apply it to geology and the processes at work in the earth's crust.

When he was preparing data for Special Publication No. 10,[1] George R. Putnam, then a member of the Coast and Geodetic Survey, suggested that a test of regional versus local distribution of compensation should be made. This was done for 44 stations in the United States and for 4 foreign stations. The outer limits for the regional distribution were about 19, 59, and 167 kilometers, or about 12, 37, and 104 miles in all directions from the stations. In Special Publication No. 40,[2] the data for the 44 stations were reprinted and similar data for 80 more stations in the United States were added. For purposes of study, these stations were then divided into groups according to the topographic form on which they are located. As was to be expected, only the stations in mountainous regions gave any appreciable difference in the anomalies for the different distributions of the compensation. The following summaries are taken from Special Publication No. 40 (pages 90—91) where detailed results are given:

If the most reasonable distribution is that which most nearly eliminates the gravity anomalies, we should study the data to see which one best fulfills the requirement.

[1] J. F. Hayford and W. Bowie, *The effect of topography and isostatic compensation upon the intensity of gravity*, U. S. Coast and Geodetic Survey, Special Publication No. 10. 1912.

[2] W. Bowie, *Investigations of gravity and isostasy*, U. S. Coast and Geodetic Survey, Special Publication No. 40, pp. 85–87. 1917.

A careful analysis indicates that there is no choice between the distribution locally and the distribution regionally to 12 miles, and to 37 miles. This is shown both by the individual anomalies as given in Special Publication No. 40, and by the mean anomalies with and without regard to sign in the summaries above. But when the anomalies for regional distribution to 104 miles are inspected, it is found that there are larger anomalies than for the other distributions and the means with and without regard to sign are larger than for the others.

TABLE 1.—ANOMALIES FOR 22 STATIONS IN MOUNTAINOUS REGIONS AND BELOW THE GENERAL LEVEL

	LOCAL COMPENSATION	REGIONAL COMPENSATION TO		
		12 miles	37 miles	104 miles
	dyne	*dyne*	*dyne*	*dyne*
Mean with regard to sign	0.000	+0.001	+0.003	+0.006
Mean without regard to sign	0.017	0.017	0.018	0.019

TABLE 2.—ANOMALIES FOR 18 STATIONS IN MOUNTAINOUS REGIONS AND ABOVE THE GENERAL LEVEL

	LOCAL COMPENSATION	REGIONAL COMPENSATION TO		
		12 miles	37 miles	104 miles
	dyne	*dyne*	*dyne*	*dyne*
Mean with regard to sign	+0.003	+0.003	0.000	−0.010
Mean without regard to sign	0.018	0.018	0.017	0.020

As the compensation of the topography extends to a great depth below the surface, of the order of magnitude of 60 miles, it is seen that the computed effect is practically the same whether it is distributed for a reasonable distance around the feature or is directly beneath it.

If the data referred to above were the only direct or indirect evidence available, we should conclude that nothing could be said in favor of any particular horizontal distribution out to a distance of about 60 miles from the topographic feature.

It is worthy of mention that George R. Putnam, who was the first to make a quantitative test of the theory of isostasy, has held that the regional distribution of compensation is nearer the truth than local distribution.[3]

[3] G. R. Putnam, *Condition of the earth's crust and the earlier American gravity observations*, Bull. Geol. Soc. Amer. **33**: 287-302. 1922.

TABLE 3.—EFFECT OF GRAVITY ANOMALIES OF THE COMPENSATION FOR INNER ZONES

NUMBER AND NAME OF STATION	ELEVATION H	ISOSTATIC ANOMALY	COR. TO DISCARD COMP. OUT TO AND INCLUDING		ANOMALIES WITH ISOSTATIC COMP. OMITTED TO	
			17.9 miles	36.5 miles	17.9 miles	36.5 miles
	meters	*dyne*	*dyne*	*dyne*	*dyne*	*dyne*
41 Wallace, Kans	1005	−0.012	−0.027	−0.048	−0.039	−0.060
42 Colorado Springs, Colo	1841	−0.007	−0.054	−0.094	−0.061	−0.101
43 Pikes Peak, Colo	4293	+0.021	−0.070	−0.113	−0.049	−0.092
44 Denver, Colo	1638	−0.016	−0.038	−0.076	−0.054	−0.092
45 Gunnison, Colo	2340	+0.020	−0.063	−0.120	−0.043	−0.100
46 Grand Junc., Colo	1398	+0.024	−0.041	−0.082	−0.017	−0.058
47 Green River, Utah	1243	−0.021	−0.033	−0.067	−0.054	−0.058
48 Pleasant Val. Junc., Utah	2191	+0.004	−0.060	−0.103	−0.056	−0.099
49 Salt Lake City, Utah	1322	+0.010	−0.040	−0.075	−0.030	−0.065
50 Grand Canyon, Wyo	2386	−0.002	−0.061	−0.108	−0.063	−0.110
51 Norris Geyser Basin, Wyo	2276	+0.021	−0.059	−0.104	−0.038	−0.083
52 Lower Geyser Basin, Wyo	2200	−0.001	−0.058	−0.103	−0.059	−0.104
55 Mt. Hamilton, Cal	1282	−0.003	−0.014	−0.017	−0.017	−0.020
63 El Paso, Tex	1146	+0.007	−0.030	−0.054	−0.023	−0.047
64 Nogales, Ariz	1181	−0.050	−0.029	−0.046	−0.079	−0.096
67 Goldfield, Nev	1716	−0.013	−0.043	−0.074	−0.056	−0.087
68 Yavapai, Ariz	2179	+0.001	−0.045	−0.080	−0.044	−0.079
70 Gallup, N. Mex	1990	−0.013	−0.053	−0.095	−0.066	−0.108
71 Las Vegas, N. Mex	1960	+0.003	−0.053	−0.094	−0.050	−0.091
75 Lead, S. Dak	1590	+0.052	−0.038	−0.064	+0.014	−0.012
81 Sisson, Cal	1048	−0.010	−0.033	−0.058	−0.043	−0.068
82 Rock Springs, Wyo	1910	+0.013	−0.052	−0.093	−0.039	−0.080
98 Alpine, Tex	1359	+0.021	−0.034	−0.061	−0.013	−0.040
99 Farwell, Tex	1259	−0.016	−0.030	−0.055	−0.046	−0.071
102 Cloudland, Tenn	1890	+0.004	−0.025	−0.039	−0.021	−0.035
109 Sheridan, Wyo	1150	+0.032	−0.032	−0.068	0.000	−0.036
110 Boulder, Mont	1493	−0.015	−0.046	−0.077	−0.061	−0.092
114 Truckee, Cal	1805	−0.028	−0.051	−0.085	−0.079	−0.113
115 Winnemucca, Nev	1311	−0.009	−0.032	−0.062	−0.041	−0.071
116 Ely, Nev	1962	−0.021	−0.055	−0.094	−0.076	−0.115
117 Guernsey, Wyo	1322	+0.036	−0.031	−0.062	+0.005	−0.026
195 Lander, Wyo	1635	+0.019	−0.047	−0.090	−0.028	−0.071
198 Edgemont, S. Dak	1066	+0.054	−0.028	−0.052	+0.026	+0.002
202 Moorecroft, Wyo	1295	+0.021	−0.031	−0.058	−0.010	−0.037
269 Hill City, S. Dak	1518	+0.042	−0.040	−0.067	+0.002	−0.025
270 Newcastle, Wyo	1328	+0.029	−0.035	−0.064	−0.006	−0.035
271 Bridgeport, Neb	1114	−0.008	−0.029	−0.053	−0.037	−0.061
272 Buford, Wyo	2396	+0.046	−0.057	−0.100	−0.011	−0.054
273 Boulder, Colo	1630	−0.014	−0.048	−0.092	−0.062	−0.106
274 Lafayette, Colo	1595	−0.020	−0.040	−0.081	−0.060	−0.101
275 Brighton, Colo	1511	−0.006	−0.038	−0.073	−0.044	−0.079
276 Idaho Springs, Colo	2303	+0.022	−0.068	−0.120	−0.046	−0.098
Mean with regard to sign		+0.005	0.043	0.077	−0.037	−0.072
Mean without regard to sign		0.019			0.049	0.072

Further evidence regarding the isostatic condition of the earth's crust is given in Table 3[4] which shows the effect on gravity anomalies of not taking into account the negative attraction of the compensation of the topography within certain distances of 42 stations. Each station used in the test has an elevation of more than 3000 feet. It is evident that the anomaly will be affected in proportion to the average thickness of the disc of topography whose compensation is ignored. Thus for an average elevation of 6000 feet the change in the anomaly will be one half that of 3000 feet. The elevations of the stations given in the table do not represent the average elevation of the surface forms considered. Some stations are on a peak or ridge above the general level, whereas others are in valleys below the average elevation of the surrounding region.

Let the ordinary method of compensation whose anomalies are shown in column 3 be called A; the one in which compensation is ignored for topography out to 17.9 miles, anomalies for which are in column 6, be called B; and the third method, the anomalies of which are shown in column 7 be called C. A careful inspection of the table shows that the A anomalies are, in nearly all cases, smaller than those for either the B or C methods.

The smallness of the A, as compared with the B and C anomalies, is shown best as tabulated below.

TABLE 4.—ANOMALIES WITHOUT REGARD TO SIGN

LIMITS		NUMBER BY		
		Method A	Method B	Method C
dyne	*dyne*			
0.000	0.0C9	12	4	1
0.010	0.019	11	6	1
0.020	0.029	12	4	3
0.030	0.039	2	5	4
0.040	0.049	2	8	2
0.050	0.059	3	6	3
0.060	0.069	0	6	4
0.070	0.079	0	3	5
0.080	0.089	0	0	3
0.090	0.099	0	0	7
0.100	0.109	0	0	6
0.110	0.119	0	0	3

If the sign of the anomalies is considered, it is found that for A, 22 are positive and 20 negative; for B, 4 are positive and 37 negative; while for C, only 1 is positive and 41 are negative.

[4] Copied from Proc. Nat. Acad. Sci. 7: 24. 1921.

If, for a large area, a gravity anomaly map were constructed, similar to illustration No. 11 of Special Publication No. 40 of the Coast and Geodetic Survey, it would be found that the high ground would be distinctly indicated on the B and C anomaly maps, while for the A map the high ground bears no relation to the anomaly contours.

If it is agreed that the method employed in gravity reductions which most uniformly reduces or eliminates the anomalies is the most probable, we must conclude that the A method is better than either the B or C method. A disc of topography 3000 feet in thickness and 18 miles in radius does not escape compensation to a marked degree. This conclusion seems to be inevitable, for not only is there the evidence from gravity anomalies, but topography in the form of masses above sea level is caused by the process or processes which change the density in the earth's crust below. As the larger surface features are caused by what we have been accustomed to call the compensation, instead of the compensation being caused in some way by the surface features, it is reasonable to believe that there is not much more topography than there is compensation.

If the crust under any area were in equilibrium before uplift, and if uplift is due to expansion and change in volume without any change in mass, the portion of the crust in question should still be in equilibrium. At least it would not be heavier than normal. But after uplift there is erosion acting as an active agent in removing material. If the earth's crust were sufficiently strong it would resist the tendency for the crust under the eroded area to move upward under gravitational forces. Gravity anomalies at stations in areas of erosion indicate that the crust below is in equilibrium, and the inference is that the material of the crust has been moved upward by the nucleal material which has been forced under it to restore the equilibrium.

The gravity anomalies and abstract reasoning both favor the idea that even masses of moderate size above sea level are not extra loads on the crust. The anomalies do not enable us to know whether the compensation is directly under a topographic feature or distributed in the crust at some distance horizontally from the column directly below the feature.

That the earth's crust has ability to resist certain stress differences is beyond question. There are stress differences in the crust between high areas and adjacent lower ones. The fact that areas have been high ones for long periods of time proves that the material of the crust is sufficiently strong to prevent a column of small cross-section being in isostatic equilibrium independent of the small columns surrounding

it. Should a peak such as Mt. Shasta, with a base of small area, lose material by erosion more rapidly than the areas of lower elevation surrounding it, surely the column under Shasta about 60 miles in length would not be pushed up by the isostatic adjustment more rapidly than the small columns adjacent to it. If the crustal material were so weak as to permit this, then surely the base of Shasta would collapse and push out under the surrounding area resulting in a more uniform elevation of the surface of the whole region. The area under and around Shasta must be what may be termed an isostatic unit. The test described in the first pages of this paper gives some idea of the maximum horizontal dimensions of this unit.

When a major uplift takes place by thermal and other type or types of expansion, in an area presumably in equilibrium, there will be much resistance to be overcome. The unaffected crust to the sides of the expanding material tends to resist free movement. Presumably the greatest expansion will occur in that portion of the crust which is overlaid by the deepest sedimentary beds, and the least expansion should be under the thinnest sediments. The expansions of different portions of the material should progress at different rates and even at different times.

The expansion of any small unit of the crust tends to be in all directions, but there is very strong resistance to movement downward and to the sides, and the general direction of least resistance will be upward. But the upward resistance will vary from place to place. When a large amount of material has been forced up directly over a very active region, the gravitational resistance to further uplift may be greater than the resistance of the material surrounding it. Further uplift would occur along inclined directions, and some of the topography formed by the expanding material would not be directly above the latter. Here there would be regional rather than local distribution of the compensation. Strictly, we should say we would have regional rather than local distribution of the topography, since the change in density (called compensation) is the cause of the masses (topography) above the plane of reference which is sea level. In the case of original uplift the isostatic unit appears to be larger in cross-section than that of the column of the crust directly under the uplifted feature.

The computations of the effect of the topography and of the isosatic compensation on the value of gravity are made for small areas and columns, but this is done to facilitate the work. This method does not in any way detract from the reliability of the gravity anom-

alies obtained. The values of the anomalies would be the same within several units if the compensation were made for any other horizontal distribution out to a moderate distance from the topographic features.

The writer and many other students of the earth's crust believe the theory of isostasy is substantially true. The major uplift at least must then be due to expansion and increase in volume of the crust beneath the affected area, and the isostatic adjustment or movement of matter to restore equilibrium as erosion and sedimentation occur must be below rather than within the crust.

We do not know the method of distribution of the compensation vertically, nor do we know the depth of compensation, for this is a function of the vertical distribution. We do know that, in order to eliminate gravity anomalies to the extent to which uniform vertical distribution does, the center of gravity of the compensation must be between 30 and 50 kilometers below the surface.

We are able to account for many of the larger gravity anomalies by the presence of abnormally light or heavy material near the gravity stations. This is especially true of those stations over large masses of pre-Cambrian and Cenozoic material. The stations on Puget Sound and on and near the Black Hills in South Dakota are notable examples. In consequence of being able thus to account for most of the large anomalies,[5] we are justified in claiming a more perfect equilibrium of the earth's crust than would have been justified several years back when the anomalies were supposed to have been due largely to lack of equilibrium.

It appears to be reasonably certain that a mass of the crust 3000 feet or more in thickness, with a radius of 18 miles is largely compensated. We do not know the cross-section of the isostatic unit of the earth's crust, although the tests with gravity anomalies indicate it to be probably less than 100 miles in radius. The configuration of the earth's surface in a mountain area is a function of the chemical compostition of the crustal material below, the manner in which sediments were laid down before the uplift began, the expansion of the crustal material, and the distribution of resistances to resulting upward movement, to the irregular erosion of the uplifted area, and to the distribution of resistances to the upward movement of crustal material as nucleal material is forced below the crust to balance the effect of erosion.

All of the problems outlined above are important ones, but not the least important is the determination of the cross-section of

[5] In U. S. Coast and Geodetic Survey, Special Publication No. 40, 1917, this explanation of large gravity anomalies is outlined for the first time.

the isostatic unit. It is not very small nor is it very large. The writer feels that it is from 25 to 50 miles in radius. It is believed that much may be learned on this matter by the combined efforts of the geologists, geophysicist, geochemist, and the geodesist.

MINERALOGY.—*Chlorophoenicite, a new mineral from Franklin Furnace, New Jersey*[1] (Preliminary description). WILLIAM F. FOSHAG, National Museum and R. B. GAGE, Trenton, New Jersey.

The material herein described was collected by one of us (R. B. G.) at Franklin Furnace, New Jersey during the year 1923. Upon examination, it proved to be a new species, and the name chlorophoenicite[2] (χλωρος. = green, φοινικος = purple red), in allusion to the property it possesses of changing from green in natural light to a light purplish red in artificial light, is here given it.

Chlorophoenicite is a hydroxyarsenate of manganese and zinc carrying minor percentages of lime and magnesia. Pure, homogeneous material yielded the following analysis:

TABLE 1.—COMPOSITION OF CHLOROPHOENICITE

	ACTUAL ANALYSIS	THEORETICAL
H_2O	11.60	11.4
CaO	3.36	
MgO	1.34	
FeO	0.48	
MnO	34.46	38.5
ZnO	29.72	29.3
As_2O_5	19.24	20.8
Total	100.24	100.0

This analysis leads to the formula 10 $RO \cdot As_2O_5 \cdot 7H_2O$ and a ratio of Mn to Zn of approximately 6:4. This may also be written $R_3As_2O_8 \cdot 7R\,(OH)_2$, a composition remarkable in its low ratio of arsenate to hydroxide. The theoretical composition of this compound with a ratio of Mn:Zn of 6:4 is given in Table 1.

When heated in the closed tube, these crystals give off water at a fairly low temperature, retain their shape, become black in color with a highly brilliant luster. The surface of the tube is not coated or colored by any arsenic coating.

[1] Published by permission of the Secretary of the Smithsonian Institution.
[2] The writers are indebted to Dr. H. S. Washington for suggesting this name.

Under the blow pipe, the crystals darken instantly, but only fuse with difficulty on the edges. They do not decrepitate or exfoliate. The brilliant luster shown in the closed tube is destroyed and the faces of the crystal become rough and porous. These tests easily distinguish these crystals from green willemite crystals of a similar shape and color which do not darken in a closed tube and fuse fairly easily in a blow pipe flame.

The chlorophoenicite forms long prismatic crystals ranging in size up to 8 mm. The crystal system is monoclinic and the crystals, elongated in the direction of the b axis, have a habit similar to epidote. The crystals are deeply striated parallel to the b axis and the small prism faces are rounded and usually etched. The color is a light grayish green in natural light but is pink or light purplish red in artificial light. This difference in color is more pronounced on the prism faces than on the pinacoids. The plane of the optic axes is across the prisms. 2V is large with a dispersion of $\rho > \upsilon$ and strong; the indices of refraction are, $\alpha = 1.682$, $\beta = 1.690$ $\gamma = 1.697$.

Chlorophoenicite occurs in cracks and crevices in the typical franklinite-zincite are of Franklin Furnace, New Jersey. It is associated with small rose red crystals of leucophoenicite, brown tephroite and calcite. The chlorophoenicite itself is very similar in appearance to the light green willemite that is found in some of the crevices and might at first glance be mistaken for it.

BOTANY.—*A new genus of Leguminosae.* Charles V. Piper, Bureau of Plant Industry.

A Costa Rican climbing shrub or liana collected 25 years ago by Tonduz seems clearly to represent an undescribed genus related to *Calopogonium* Desvaux. The large leaflets, closely resembling the leaves of the aspen, and the dense racemes of very small pubescent yellowish flowers are conspicuous characters.

Leycephyllum Piper, gen. nov.

Climbing shrub; leaves trifoliolate, the leaflets entire; stipules striate; flowers small, yellowish, numerous, in racemes from the axils of the upper leaves; calyx campanulate, the upper lip short bidentate, the lower lip 3-toothed, the median one as long as the calyx-tube, the lateral ones short; standard obovate, stipitate, the upper margin incurved or hooded, the base without callosities or auricles, but the basal margins thickened; wing oblong, stipitate, the auricle somewhat hook-like; keel oblong-obovate, stipitate, not auricled; vexillar stamen free, its filament enlarged at base, the other stamens united below, free above the middle; anthers oval; style curved, glabrous; stigma terminal, very oblique, minute; ovary pubescent.

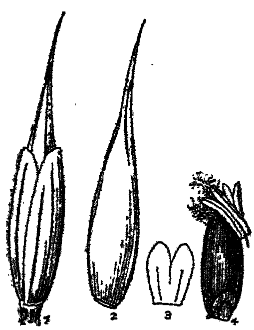
Leycephyllum micranthum Piper, sp. nov.

Stems terete, densely puberulent when young, becoming glabrous; stipules lanceolate, striate, puberulent, 3 to 4 mm. long; petioles terete, channelled above, faintly striate-ridged, puberulent, usually longer than the leaflets; stipels apparently wanting; petiolules very pubescent; leaflets entire, firm membranaceous, broadly ovate to suborbicular, 3-nerved from the base, strongly acuminate and short-apiculate, broadly cuneate to rounded or even subcordate at base, sparsely puberulent above especially on the nerves, less so beneath, 8 to 10 cm. long; peduncles densely brown puberulent, floriferous from near the base, knotted with the pedicellar glands, 5 to 6 cm. long including the racemes of numerous flowers; bracts lanceolate, 3 mm. long, narrowed at base, long attenuate to apex, densely puberulent, much longer than the buds; pedicels shorter than the calyx; calyx densely brown puberulent, the tube 1.5 mm. long, the median lower tooth as long; corolla yellowish; standard 5 mm. long, puberulent on the outer side and densely covered near the tip with minute sessile glands; wings oblong, 5 mm., the auricle hook-like; keel as long as the wings, oblong-obovate, stipitate.

Type in the U. S. National Herbarium, no. 938783, collected at Las Vueltas, Tucurrique, Costa Rica, 635 meters altitude, January, 1899, by Adolpho Tonduz (no. 12951). The label notes "liane a tige aplatir; fl. jaunatres; fr. rouge et noir."

BOTANY.—Aciachne, *a cleistogamous grass of the high Andes.* AGNES CHASE, Department of Agriculture.

The genus *Aciachne* was described[1] by Bentham as dioecious, "Spiculae unisexuales, ♂ ignotae." There is one species, *A. pulvinata* Benth., "Andes of South America." Of the seven collections cited two, *Lechler* 1813 and *Mandon* 1287, are represented in the U. S. National Herbarium. Bentham states: "Notwithstanding the number of specimens from most of the above localities, I have been unable to detect any but female spikelets, which on some of them are numerous, often past flower, and showing only the persistent outer glumes. The males are probably on distinct plants and most likely with a different inflorescence, rendering it difficult to identify them. If that be the case, it is possible that the male of this, or an allied species may be represented by Lechler's specimens gathered at Gachapata in Peru a month earlier than the females above referred to, and distributed with the number 599. In these the leaves are longer, all erect, and very rigid,



Aciachne pulvinata. Fig. 1, spikelet × 10; fig. 2, floret × 10; fig. 3, palea × 10; fig. 4, caryopsis crowned by old stigmas and stamens × 20.

[1] Hook. Icon. Pl. 4: 44. *pl.* 1362. 1881.

1 to 3 in. long. The spikelets are several in a loose, slightly branched, rigid, erect panicle of 1 to 2 inches, the glumes precisely like those of the females, but enclosing three perfect stamens and the ovary reduced to an ovoid rudiment with two small points." The plate shows a flower with ovary and stigmas.

In the Genera Plantarum[2] "Spiculae unisexuales ♂ ignotae" is repeated. Hackel says[3] of *Aciachne* "♂ Ae. unbekannt."

Practically all the numerous specimens of this grass preserved in herbaria have well-developed fruit. Professor A. S. Hitchcock, in a letter from Lima, Peru, writes, "A peculiar and wonderful grass is *Aciachne*. This in some places is the dominant or even the only grass on whole hills. It is not eaten by stock. It occurs in little mounds or patches, a deep green, dying out in the center and forming fairy rings. It is commonly supposed by the people there to be a moss. The spikelets are hidden among the short prickly leaves but the little sharp-pointed fruits rattle out easily and stick in the clothing."

The fact that the plant fruits so abundantly suggested that the mystery of the staminate form might be explained by cleistogamy. Professor Hitchcock's collections contained an abundance of fruiting material. A floret boiled in glycerine and water and carefully opened disclosed two empty anthers crushed with the old stigma at the summit of the caryopsis. The anthers are nearly 1 mm. long, larger than the anthers found in some cleistogenes. All florets opened contained anthers, some two, some three. Figure 4 shows the caryopsis with stigmas and anthers as they appear (slightly loosened by needles) taken from a boiled floret. In most cases the mass of crushed stigmas and anthers fell as the caryopsis was removed, but dissection showed 2 or 3 anthers in every case. The filaments were very short, in some cases none were found. The anthers must be nearly sessile, torn loose and carried upward by the developing fertilized ovary, and finally crushed with the old stigmas against the roof of the tiny chamber within the indurate lemma.

Bentham figures a large truncate palea and a pair of long lodicules. My dissections reveal a small hyaline deeply 2-lobed palea (figure 3) and only rudimentary lodicules. The lemma is very difficult to open and can not be spread out without cutting off the acuminate summit; even then it cracks lengthwise. It seems probable that among the dissections of several florets under the microscope Bentham

[2] Benth. & Hook. Gen. Pl. 3: 1143. 1883.
[3] Engler & Prantl, *Pflanzenreich* 2[2]: 47. 1887.

found a part of a lemma from which the summit had been cut and mistook it for a palea, while the true palea split to the base in dissection was mistaken for lodicules.

We have not seen Lechler's no. 599, referred to by Bentham as possibly the staminate form of *Aciachne*. Growing with *Aciachne* at Cerro de Pasco, Peru, Professor Hitchcock found over-mature plants of *Dissanthelium calycinum* (Presl) Hitchc., which agree fairly well with Bentham's observations on Lechler's no. 599 and would appear to be the same species, though the glumes are abruptly pointed, not obtuse as in *Aciachne*.

Baillon in a note[4] on the 1-flowered inflorescence of *Aciachne* refers to it as "polygame-dioique." His description of palea and lodicules ("glumelle interieure" and "glumellules") seems to be drawn from Bentham's illustration, but he found three stamens and an ovary with plumose styles, evidently in a young spikelet. He also observes a caryopsis but does not mention the included stamens. Pilger mentions[5] *Aciachne* in a paper on monoecious and dioecious grasses.

ZOOLOGY.—*Snails of the genus* Succinea *from the Maritime Province of Sibera.* T. D. A. COCKERELL, University of Colorado. (Communicated by PAUL BARTSCH).

Dr. Leopold v. Schrenck, in his account of the mollusca of the Amur region of Siberia,[1] listed ostensibly one species of *Succinea*, namely *S. putris* Linnaeus. However, he divided this into forma *ventricosior* (*S. amphibia* Draparnaud) and forma *gracilior* (*S. pfeifferi* Rossmaessler), and if his identifications were correct, he had not only two species but two subgenera. Westerlund described two varieties of *S. putris* from Siberia, namely variety *firma* Westerlund, above whitish, beneath amber-color, whorls 4, length 16-17 mm., width 9-10 mm. (Ins. Briakowskij, n. lat 70°, 39′), and variety *hazayana* Westerlund, red yellow, whorls 4-4.5, length 19.5-22 mm., width 9-10 mm. (Tunguska N. lat. 61°). *Succinea oblonga* var. *agonostoma* Kuester is said by Westerlund to occur in Germany, Sweden, and Siberia. The variety *elongata* Westerlund is synonymous with it. *Succinea chrysis* Westerlund is found, accord-

[4] Bull. Soc. Linn. Paris **2**: 1034. 1892

[5] Bot. Jahrb. Engler **34**: 386. 1904.

[1] *Reisen und Forchungen im Amurlande in den Jahren 1854–1856.* St. Petersburg, 1859–1867.

ing to Dall,[2] from Greenland to Bering Strait and on the opposite (Asiatic) shore of the Strait.

The division of *Succinea* into subgenera has led to differences of opinion, and has perhaps been overdone, as Dall has suggested. Nevertheless, there are certainly two groups among the commoner Palearctic and Nearctic species, namely *Succinea* Draparnaud, proper (type *S. putris*), and *Amphibina* Hartmann (type *S. pfeifferi*). Not only do these differ in the appearance of the shell, but *Succinea* proper has the jaw ribbed, which is not the case in *Amphibina*. The two types of jaw are well illustrated by W. G. Binney[3] (S. *totteniana* Morse and *S. avara* Say) and by Moquin-Tandon.[4] *Lucena* Oken, originally based on *S. putris*, is *Succinea* proper as here understood. *Oxyloma* Westerlund, containing *S. dunkeri* Zelebor from Dobrudscha and *S. hungarica* Hazay from Hungary, is probably not to be separated from *Amphibina*. Both these species are so close to *S. elegans* Risso, which belongs to *Amphibina*, that good authorities have regarded them as subspecies of it.

In the Maritime Province of Siberia, during the summer of 1923, I found two kinds of *Succinea*, both of the typical subgenus, and closely related to *S. putris*. When I collected them, as they climbed the damp herbage during wet weather, they struck me as being decidedly different from *S. putris*, a species very familiar to me in England. Even in England, however, *S. putris* is variable, and from various parts of Europe numerous varieties have been described by Moquin-Tandon, Hazay, Baudon, Clessin, Colbeau, Bourguignat, Picard, Paulucci, Westerlund, and Pascal. Since there is so much similiarity in the shells of related forms of *Succinea*, it is quite possible that anatomical studies will show several of these "varieties" to be distinct species, but others are certainly phases without even racial significance. Germain[5] does not hesitate to treat *S. charpentieri* Dumont and Mortillet and *S. milneedwardsi* Bourguignat, regarded as mere varieties of *S. putris* by Westerlund, as perfectly distinct species. Owing to the uncertainty surrounding the whole subject, I present the Siberian forms as subspecies of *S. putris*, a course which at any rate calls attention to their obvious affinities. Should they hereafter be separated specifically, they will probably rank as forms of a single species, yet racially distinct, as the characters were quite uniform (except for the usual individual variation in shape) in each locality.

[2] Alaska (Harriman Expedition) **13**: 59. 1905.

[3] *The terrestrial air-breathing mollusks of the United States* **5**: 415. 1878.

[4] Hist. Nat. Mollusq. Ter. & Fluv. France **3**: *pl.* 7. 1855.

[5] Mollusques de la France **2**: 225. 1913.

Succinea putris olgae, new subspecies.

Shell 19 to 21.6 mm. long, 11 to 11.7 mm. wide; aperture 14 to 16 mm. long, 9.5 mm. wide; general form of *S. putris*, size like variety *hazayana* Westerlund, but broader and much paler, dullish pale horn color, with moderate spire. Jaw about as wide as long (1.7 mm)., ferruginous, the accessory plate usually longer than broad, thus longer in proportion to its width than in *S. putris*; ends (lateral lobes) distinctly broader than in *S. putris*; ribs low and broad, three or five; median inferior projection well developed. Lingual membrane with the teeth (centrals and laterals) only about half as long as the basal plate, the mesocone broad and very obtuse, the ectocones poorly developed; marginals dagger-shaped, curved, with a single rudimentary ectocone.

Olga, Siberia, July 13, on hill above the village (type locality); also (immature specimens) near the Kudia River, July. This is doubtless the shell which A. Adams reported as *S. putris* from Olga Bay and Vladimir Bay. *Type.*—Cat. No. 360790 U. S. N. M.

Succinea putris mera, new subspecies.

Shell 20 mm. long, 11.7 wide; aperture 16 mm. long, nearly 9 wide; general form of a very broad *S. putris*, but very thin, strongly reddish moderately shining. Jaw as in the last, except that the accessory plate is broader; lingual membrane as in the last. Animal in life very pale translucent yellowish; tentacles grey above, abruptly contracted near end.

Okeanskaja, Siberia, July and August, abundant close to the railway station. *Type.*—Cat. No. 360791 U. S. N. M.

The substantial identity in jaw and lingual membrane indicates that these forms, although locally constant in their color-differences, are conspecific. *Succinea lauta* Gould was identified by A. Adams in his collections from Vladimir Bay. *Succinea lauta* was described by Gould as found on shrubbery at Hakodate, which is in northern Japan nearly opposite Vladivostok. It was said to be a very large, thin shell, most like *S. obliqua* Say. Dr. Bartsch has kindly sent me a specimen, and it is certainly another member of the *S. putris* group, differing very little from typical *S. putris* as figured by Moquin-Tandon and Baudon. The longer spire and generally more fusiform shape distinguish it from the above-described Siberian shells, but whether it agrees with them in dental and jaw characters remains to be determined. The Japanese *S. horticola* Reinhardt, from Matsuyama, also sent by Dr. Bartsch, is an entirely different shell, apparently referable to *Amphibina*, although Pilsbry seems to think otherwise. The Japanese *S. hirasei* Pilsbry is an *Amphibina*. I do not believe any of these Japanese species occur in Siberia. The record of Adams may be safely set aside, as it has been shown in several other cases that he made serious errors in locality or identity.

Succinea ogasawarae Pilsbry and *S. punctulispira* Pilsbry, from the Bonin Islands, are much smaller than my Siberian shells; the former is a curious shell, with the spire reduced to a mere papilla. The Chinese *S. chinensis* Pfeiffer and *S. gimlettei* Jones and Preston are less than 10 mm. long, and appear to belong to *Amphibina*.

The American forms most nearly allied to *S. putris,* namely *S. ovalis* Say (*obliqua* Say) and *S. totteniana* Morse (now usually considered a race or variety of *ovalis*), differ conspicuously from my Siberian species in the jaw, which has no salient median inferior projection, and equally in the teeth, the pointed mesocones being much longer, while the marginals have two little cusps. There is thus no possibility of specific identity.

A remarkable thing about the genus *Succinea* is the presence of species on remote islands, such as the Hawaiian Islands (numerous species), Galapagos Islands Cocos Island, Clarion Island, Sokotra, etc. Darwin thought that the young might be carried on the feet of birds. Lyell thought that the eggs might be carried among the feathers of water-fowl.

ENTOMOLOGY.—*Notes on* Grylloblatta *with description of a new species.* A. N. CAUDELL, National Museum.

The examination of additional specimens of the *Grylloblatta* found in California, as recently announced[1] by the writer and of a topotypic nymph of the Canadian species *campodeiformis* Walker, makes it advisable to describe the specimens from California as belonging to a distinct species. Dr. E. M. Walker has kindly examined the holotype of the Californian form and pronounces it unquestionably distinct from the Canadian species. It is therefore here described as:

Grylloblatta barberi, new species.

The type of this species is the large male nymph discussed in the aforementioned article. In general appearance it is very like the Canadian *campodeiformis* but structurally it differs from that species as follows: The antennae are composed of a greater number of segments, their number ranging from 35 to 40 while the maximum number noted in the related species is 29 in the adult, a nymph of that form before the writer having 25. The antennae are also decidedly longer than in the Canadian form, as shown by measurements given below. The posterior femora are, as noted in the previous article, longer than in *campodeiformis,* the appended comparative measurements being illustrative. The transverse sulcus near the anterior margin of the pronotal disk is sinuate in all specimens seen while in *campodeiformis* it is straight as shown by Walker's description and illustrated in the immature specimen of that species examined. Thus the characters mentioned as differential in the former article appear to be constant and specific except for the fact that the posterior margin of the pronotal disk is obtuse-angulate in the nymphs of both species, thus being a nymphal character. The cerci are more tapering and considerably longer than in *campodeiformis* and the large nymph selected as holotype, which is very probably in the last

[1] Can. Ent. **55**: 148–150. 1923.

nymphal instar, has the same number of segments as described for adults of the Canadian form; in the earlier stages, however, only seven segments are present. The smaller female nymphs have the inner valves of the ovipositor arising caudad of the ventral ones and scarcely exceeding the tips of the latter.

The following measurements are from the four immature specmens forming the basis of the present description, from a single immature topotypic female of *campodeiformis* and from measurements given in Dr. Walker's published articles, or inferred therefrom.

		TOTAL LENGTH TO TIP OF ABDOMEN	ANTENNAE	PRONOTUM	POSTERIOR FEMORA	CERCUS	NUMBER OF SEGMENTS IN THE ANTENNAE	NUMBER OF SEGMENTS IN THE CERCUS
		mm.	mm.	mm.		mm.		
Grylloblatta barberi n. sp.	Holotype ♂ nymph.	20	15	3	5	6	40 and ?	8
	Paratype A. ♂ nymph.	19	14	2.8	4.5	5.8	39 and ?	8
	Paratype B. ♀ nymph.	17	11	2.5	4	5	35 and ?	7
	Paratype C. ♀ nymph.	18	?	?	4	4.25	36 and 38	7
Grylloblatta campodeiformis Walker.	Type, adult ♀.	30	8.5	?	3.4	3.6	26 to 29	8
	Cotype, adult ♀.	30	9	?	3.2	3.5	26 to 29	8
	Topotype, adult ♂.	16.5	?	?	?	?	? ?	8
	Topotype, ♀ nymph.	15	?	?	3.25	?	? ?	8
	*Topotype, ♀ nymph.	13	7	2	2.5	3.5	25 and 25	7
	Topotype, ♂ nymph.	11	?	?	2.75	?	22 and ?	8
	Topotype, ♂ nymph.	11	?	?	2.1	?	? ?	8
	Topotype, ♂ nymph.	12.5	?	?	3.1	?	? ?	8

*Specimen examined by the writer and now in the National Museum.

The type material of *barberi* consists of four specimens as follows: Holotype, the large male nymph, evidently in the last instar, taken by H. S. Barber on January 23, 1923, in Plumas County, California and discussed in the previous paper by the present writer;[2] paratype A, an immature male, also probably in the last instar, taken at the same locality as the holotype by F. J. Silor; paratype B, an immature female specimen of an earlier instar than the above but with the same data; paratype C, with same data as the last and evidently in the same stage of development.

Holotype and paratypes A and B in the collection of the United States National Museum; paratype C sent in exchange to Dr. E. M. Walker.

Cat. no. 27265 U. S. N. M.

The writer takes pleasure in dedicating this interesting species to Herbert S. Barber of the National Museum in recognition of his ability to discover interesting and unusual forms of insect life in unsuspected places.

[2] See footnote 1.

NOTES

The paratypes of *Grylloblatta barberi* were taken by Mr. Silor some five hundred feet above the point where Mr. Barber collected the holotype, one being found in an outhouse and the others under pieces of timber. Mr. Silor writes that if they are exposed by turning over the timber on a hot day and the sun hits them, they move slowly, but if they are found on a cloudy day they run rapidly. Dr. Walker writes that living specimens of *Grylloblatta campodeiformis* observed by him ran about like cockroaches, and would eat nothing but cake; Mr. Hearle found, however, that they would feed readily on flies with the wings removed, and Dr. C. G. Hewitt fed specimens on ant pupae.

The antennae of *Gryloblatta* bear sensory pits, small circular scars present on all segments except the apical one. There are several on each segment forming a preapical circle around each segment except the basal one, where they are apparently absent on the dorsal surface. From each of these scars or pits arises a very long and slender tactile hair, longer than the setae and finer than the ordinary hairs. These organs are present in both species of *Grylloblatta* and also in the Asiatic *Galloisiana nipponensis* of Caudell and King, though in the latter species they are less obvious.

Both species of *Grylloblatta* and *Galloisiana nipponensis* possess an invaginated gland which opens between the first and second ventral abdominal segments. Normally this gland is noticeable only as a pair of transverse, closely appressed lips, but in two of the immature specimens of *Grylloblatta barberi* a soft, white, tongue-like process is protruded; in the larger nymph this process is about three-fourths of one millimeter in length and about one-fourth as thick as long. This gland is present in both sexes and in a single immature specimen of *Grylloblatta campodeiformis* studied by the writer it is partly protruded and the apex appears truncate and slightly chitinized, an appearance not noticed in *barberi*. On the posterior margin of the basal segment of the abdomen, just above this gland, there is a pair of small setae. In *Galloisiana nipponensis* this gland is obscurely indicated in the two alcoholic nymph studied, being not at all extruded; the only adult specimen of that species seen has the venter mostly eaten away by ants. The glandular structure discussed above can not be satisfactorily investigated without dissection, and limited material makes this inadvisable.

Dr. Walker in his description of the nymphs of *Grylloblatta campodeiformis* notes that the cerci consist of eight segments, the same as in the adult, but with the basal two segments less distinctly separated. This is not true, however, of a topotypic nymph of that species examined by the present writer, as in this specimen the cerci are but seven segmented, and the basal one of these seven segments is so closely amalgamated with the succeeding one as to be recognized as distinct only by setal arrangement and the position of sensory pits.

MAMMALOGY.—*Two new kangaroo rats from Arizona.* E. A. GOLDMAN, Biological Survey.

Among the results of recent field work in northern Arizona have been the discovery of two undescribed kangaroo rats of the genus *Dipodomys*. These are characterized as follows:

Dipodomys microps celsus, subsp. nov.

Virgin Valley Kangaroo Rat.

Type from 6 miles north of Wolf Hole, Arizona (altitude 3,500 feet). No. 243101, ♂ adult, U. S. National Museum (Biological Survey Collection)' collected by E. A. Goldman, October 16, 1922. Original number 23411.

General characters.—Closely allied to *Dipodomys microps levipes*, but size usually larger and color slightly darker, the back more obscured by dusky hairs; skull differing most noticeably in larger size of mastoid bullae; hind foot with five toes as usual in the species. Decidedly larger than *D. m. microps* and differing otherwise as from *D. m. levipes*.

Color.—*Type* (fresh pelage): Upper parts in general near pinkish buff, moderately mixed with black, the buffy element purest and most intense along sides of body, becoming lighter buffy on head and face; under parts, postauricular spots, fore limbs, hind feet above, usual hip stripes, and tail at extreme base all around pure white; tail beyond extreme base blackish along upper and lower median stripes to near tip where thelengthening hairs become dusky all around, the sides white to subterminal area mentioned; pencilled tip of tail inconspicuously dusky, the dark points of hairs only partially concealing the white under color; hind legs immediately above ankles blackish, except a white line along inner side; soles of hind feet black to toes, which are white; usual dark facial markings broad and distinct.

Skull.—Similar to that of *D. m. levipes*, but broader, more massive; mastoid bullae decidedly larger; maxillary arches slightly broader; dentition about the same. Compared with that of *D. m. microps* the skull is decidedly larger and differs in other respects as from that of *D. m. levipes*.

Measurements.—*Type:* Total length, 284; tail vertebrae, 170; hind foot, 44. Average and extremes of 10 adults, including type, from type locality: 285.6 (277–298); 171.3 (164–182); 43.4 (42.5–44). *Skull* (type): Greatest length on median line, 36; greatest breadth (between outer sides of audital bullae), 25.3, breadth across maxillary arches, 20; least width of suproccipital (near interparietal), 1.2; maxillary toothrow, 5.

Remarks.—While closely allied to the widely ranging subspecies *D. m. levipes*, this kangaroo rat is readily distinguished by the cranial characters indicated. Its geographic range appears to be the upper part of the Virgin River Valley and adjacent parts of the plateau region in Utah and Arizona.

Specimens examined.—Total number, 20, from localities as follows:

ARIZONA: Wolf Hole (type locality 6 miles north, 12; Kanab Wash (near southern boundary Kaibab Indian Reservation), 1.

UTAH: Saint George, 7.

Dipodomys ordii cupidineus, subsp. nov.

Kaibab Kangaroo Rat.

Type from Kanab Wash, at southern boundary of Kaibab Indian Reservation, Arizona. No. 243093, ♂ adult, U. S. National Museum (Biological Survey Collection), collected by E. A. Goldman, October 12, 1922. Original number 23384.

Qeneral characters.—Closely allied to *Dipodomys ordii utahensis*, but general color of upper parts much brighter and richer, near cinnamon-buff instead of dull clay color; hind foot with five toes. Externally resembling *D. o. longipes* and *D. o. richardsoni*, but cranial characters widely different.

Color.—*Type* (fresh pelage): Upper parts in general near cinnamon-buff of Ridgway, this color purest along sides and on hind legs, becoming paler on the face and over top of head and back evenly but rather inconspicuously lined with dusky hairs; under parts, forelimbs, hind feet above, supraorbital and postauricular spots, hip stripes and tail at base all around pure white as usual in the group; inner sides of ears clothed with blackish hair; tail beyond extreme base blackish along upper median stripe to tip and along lower median stripe which narrows gradually until interrupted subterminally by a white area continuous with white lateral stripes; soles of hind feet and small isolated spots just above heels on outer sides blackish.

Skull.—Essentially like that of *D. o. utahensis*. Compared with that of *D. o. longipes*, the skull is smaller with shorter rostrum, the mastoid and audital bullae are relatively decidedly smaller, and the supraoccipital and interparietal are broader, more widely separating mastoid bullae.

Measurements.—*Type:* Total length, 257; tail vertebrae, 150; hind foot, 41. *Skull* (type): Greatest length on median line, 36.4; greatest breadth (between outer sides of audital bullae), 24.9; breadth across maxillary arches, 21.1; least width of supraoccipital (near interparietal), 2.5; maxillary toothrow, 4.7.

Remarks.—The geographic range of *D. o. cupidineus* is the Kaibab plateau region of northern Arizona, and adjacent parts of southern Utah. In color this subspecies closely resembles *D. o. longipes* which inhabits similar territory south of the Colorado River, but differs widely in cranial characters as already indicated. The Colorado River and its great canyon evidently form an effective barrier separating the ranges of the two forms.

Specimens examined.—Total number, 26, as follows:

ARIZONA: Cane, Houserock Valley, 2; Diamond Butte, 1; Fredonia, 2; Houserock, Houserock Valley, 2; Hurricane Ledge (6 miles north of Mount Trumbull, 1; Kanab Wash (type locality), 1; North Canyon (at edge of juniper belt), 4; Trumbull Mountains (5 miles south of Trumbull Spring), 1.

UTAH: Kanab, 11; Pipe Spring, 1.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE GEOLOGICAL SOCIETY

387TH MEETING

The 387th meeting was held in the Auditorium of the Department of the Interior on Wednesday, January 9, 1924, President Wright presiding, and 53 persons present.

Informal communication: FRANK L. HESS.—*Corundum crystals from Bandalierkopf, Transvaal.* Discussed by F. E. WRIGHT.

Program: L. H. ADAMS.—*Behavior of rocks under pressure.* Discussed by Messrs. RICE and BOWIE.

S. R. CAPPS.—*An early Tertiary placer deposit in Alaska.* In the Cache Creek gold placer mining district, in the basin of Yentna River, a western tributary of the Susitna, recent mining developments have disclosed a heavy

deposit of subangular quartz fragments at the base of the Tertiary (Eocene) coal-bearing formation. This quartzose deposit, which contains angular, uneroded gold in minable amounts, lies upon a deeply weathered erosion surface of Mesozoic argillites and graywackes and is overlain by Tertiary sands, shales and lignite, which themselves are buried beneath a heavy mantle of glacial till that also contains some placer gold. The entire section, including 50 feet of subangular quartz, 50 feet of Teritiary sandstone and shale, and 100 feet of glacial till, contains enough gold so that it has all been mined by hydraulic methods.

The layer of subangular quartz fragments at the base of the Tertiary beds and its contained gold are believed to represent a residual accumulation on the exposed surface of the Mesozoic rocks resulting from a long period of late Mesozoic or Early Tertiary erosion. The character of the quartz fragments is the same as that of abundant quartz gash veins and bunches in the Mesozoic rocks, and the subangular shapes of the quartz fragments, as well as the rough and unworn character of the placer gold, indicate a bedrock source near at hand. The quartzose deposit is the base of the Tertiary section at this place, and represents an early Tertiary placer accumulation. The gold of the present stream placers has been derived chiefly from the Tertiary deposits and the glacial till, by post-glacial concentration, and only to a small extent from the original bedrock source through erosion by the post-glacial streams. (*Author's abstract.*)

Discussed by Messrs. HEALD, LEE, ALDEN, SCHRADER, BROOKS, and WRIGHT.

R. S. BASSLER.—*Sinkhole structure in central Tennessee.* The Central Basin of Tennessee underlaid by various Ordovician limestone formations and the surrounding Highland Rim exposing several Mississippian limestones, exhibit a variety of sink-hole phenomena. On the Highland Rim, typical sink-holes are often developed through the formation of caves in the Ordovician limestone and the falling in of the roof of Mississippian limestones with the result that the latter strata now surround the sink-hole in a vertical position. On the western Highland Rim ancient sink-holes are filled by brown iron ore bodies. Further west in Decateur County white phosphate occupies such sink-holes in Silurian limestone. In the northern part of the Central Basin, sink-holes in Ordovician limestone are occasionally completely filled to a depth of 30 or 40 feet by the Early Mississippian Hardin sandstone which elsewhere in the vicinity is only a few inches thick. In Central Tennessee the strata occasionally follow the topography, that is, the same stratum may be found to rise with a hill and then descend to the bottom with it on the other side. This phenomenon, instead of being original structure, may be due to the slumping of the strata because of sink-hole formation. (*Author's abstract.*)

388TH MEETING

The 388th meeting, a joint meeting with the Washington Academy of Sciences and the Philosophical Society of Washington, was held in the Auditorium of the Department of the Interior January 23, 1924, President A. L. DAY of the WASHINGTON ACADEMY OF SCIENCES in the chair, and 403 persons present. Dr. T. A. JAGGER, Director of the Hawaiian Volcano Observatory, delivered two addresses:

1. *The Hawaiian volcanoes*, a summary of systematic observations at Kilauea and the salient recent discoveries in volcanology. Illustrated by lantern slides.

2. *The Tokyo earthquake*, a summary of the earthquake and a comparison of its disasterous effects with those of the Sakurajima eruption of 1914. Illustrated by two rolls of motion pictures. Dr. JAGGER visited Tokyo in September, 1923, and obtained possession of an extraordinary film taken the day of the earthquake.

389TH MEETING

The 389th meeting was held in the Auditorium of the Department of the Interior February 13, 1924, President Wright presiding and 56 persons present. The Secretary announced the resignation of N. M. FENNEMAN, EDSON S. BASTIN, MISS MARTHA D. BENNETT, and MISS ELSIE PATTERSON.

Program: W. F. FOSHAG.—*Saline playa lakes of the Mojave Desert.* This paper, which was illustrated by lantern slides, was discussed by Messrs. HESS, WHITE, FERGUSON, W. M. DAVIS, and WRIGHT.

SIDNEY PAIGE and W. T. FORAN.—*A reconnaissance of the Arctic coast of Alaska, 1923.* Discussed by Messrs. HESS, HEWETT, and WRIGHT.

JOINT MEETING

A joint meeting of the society and the WASHINGTON ACADEMY OF SCIENCES was held at the Cosmos Club Thursday, February 21, 1924, President Wright of the Geological Society presiding.

Program: Dr. ALFRED C. LANE of Tufts College.—*The age of the earth and the oceans.*

390TH MEETING

The 390th meeting was held in the Auditorium of the Department of the Interior February 27, 1924, President WRIGHT presiding. Attendance 56. The Secretary presented resignations from C. E. LESHER and S. S. VISHER.

Program: PROF. WM. M. DAVIS.—*Gilbert's theory of laccoliths.* The paper outlined Gilbert's analysis of the conditions under which the intrusion of the Henry Mountain laccoliths took place, with special regard to the evidence for the fluidity of the magma at the time of intrusion, and for the limitation of the dimensions of laccoliths by certain mechanical factors. Hence, for Gilbert, a laccolith was not simply a great blister-like mass of instrusive rock, but an intrusive mass that had taken its place in blister-like forms in a special manner.

If the mechanical principles that are exemplified by the regular laccoliths of the Henry Mountains do not explain laccoliths of more irregular form and distribution elsewhere, that should not be taken to prove that Gilbert's relatively simple explanation of the Henry Mountain laccoliths is in error, but rather that an elaboration of his explanation should be proposed, whereby it can be adapted to more complicated occurrences.

The case of intrusive sheets of greater horizontal extent than the limiting diameter of the Henry Mountain laccoliths also calls for special explanation. A factor that Gilbert did not especially consider is the rate of intrusion; if it be imagined that intrusions may take place at a slow, an intermediate, and a rapid rate, perhaps extensive sheets may be the result of slow intrusion; regular laccoliths may be the result of intrusion at an intermediate rate; and irregular laccoliths may be the result of rapid intrusion. (*Author's abstract.*)

Discussed by Messrs. HESS, WRIGHT, WASHINGTON, CROSS, PAIGE, and LAWSON.

Prof. A. C. LAWSON.—*Some geological implications of isostasy.*

Discussed by Messrs. WRIGHT, ALDEN, STOSE, WASHINGTON, DAVIS, and COOKE.

391ST MEETING

The 391st meeting was held in the Auditorium of the Department of the Interior March 12, 1924, Vice-President HEWETT in the chair, and 47 persons present. The resignation of ELEANOR F. KNOPF was announced.

Program: J. BRIAN EBY.—*The carbonization of some Colorado coals by igneous intrusion.* The opportunity to study the effects of igneous intrusion on bituminous coal beds is offered by a series of surface and borehole prospects on the Shelton Tract in the northeast corner of the Yampa coal field, Colorado. Nine beds of coal occur overlying a basaltic sill that is approximately 75 feet thick. The coal occurs in 200 feet of sandstone and shale beds, the two most important beds lying at 60 and 170 feet above the sill, and averaging about 4 feet and 8 feet thick, respectively. The area is described by H. S. Gale and N. M. Fenneman in Bulletin 298 of the Geological Survey, page 72.

Fifteen drill holes were put down and surface pits were opened to prospect the coals. E. Shelton, of hayden, owner of tract, reported to writer wells were churn drilled. Dr. T. W. Stanton, who visited the locality in 1905 with Gale, reports that wells were core drilled. It was found that the coals nearest the sill were carbonized or anthracitized and presented many of the physical features of the Pennsylvania anthracite. The correlated well records, making use of the drillers' classification of the coal, indicate that all coal within 60 feet of the sill is anthracitized, that 50 per cent of the coals from 65 to 105 feet above the sill show effects of carbonization, and that coals more than 110 feet above the sill are unaffected.

The sill rock, examined in thin section by C. S. Ross, is a fine-grained olivine basalt, derived apparently from a dry magma that cooled slowly under cover. The overlying sandstone and shale beds, of which the latter predominate, are apparently not affected except for a few inches at the actual contact. Thin sections of a sandstone overlying the sill about 50 feet give no evidence of metamorphism. The fact, however, that the coals are carbonized in places up to 105 feet above the sill emphasizes the sensitive character of carbonaceous deposits to local metamorphism.

An effort was made to account for the irregular upward limit of the anthracitization, but field observations gave no tangible results. The occurrence of lentils of sandstone in shale or lentils of shale in sandstone between the sill and the coal bed would to some extent serve to give the upward limit of anthracitization an uneven or wavy surface. The surface examination of the Shelton tract, which is well timbered country, scarcely justifies this explanation although the rocks involved, middle Mesaverde in age, in adjoining territory exhibit to some extent lenticular character. (*Author's abstract.*)

Discussion by Messrs. CAPPS, SAMPSON, WHITE, SPENCER, and FORAN.

H. G. FERGUSON and S. H. CATHCART.—*Major structural features of some western Nevada ranges.* The portions of the Hawthorn and Tonapah quadrangles covered by the present reconnaissance comprise an area of about 5,000 square miles of basin range country lying just east of the Sierra Nevadas. As is common within the Basin Range Province, the principal surface features are a series of ranges separated by desert valleys. The eastern and the western ranges have a northerly trend; in the central part they have a sinuous northwest trend; while in the southern part the trend is east.

The rocks of the region range in age from Cambrian to Quarternary. The Paleozoic is represented by the Cambrian, Ordovician, Devonian, Pennsylvanian, and Permian. At least three marked unconformities are recognized; namely, between the Triassic and Permian, between the Permian and Pennsylvanian, and between the Pennsylvanian and Devonian. Angular discordance is noted only at one locality; between the Permian and Ordovician. The Carboniferous is represented in this region by less than 300 feet of strata. To the northeast and to the south, it is much thicker. At Eureka, it is 18,000 feet; in the Inyo region, it is more than 8,000 feet thick.

The Mesozoic is represented by sedimentary and volcanic rocks of Triassic and Jurassic age and by plutonic rocks of late Jurassic or Cretaceous age. One pronounced angular unconformity is observed within the Mesozoic, probably within the lower Jurassic. Plutonic rocks chiefly quartz monozonite occur in isolated areas throughout the region and are believed to represent a single epoch of intrusion.

The Tertiary and Quaternary are represented chiefly by volcanic flows with which occur lacustrine sediments and alluvial deposits. The subdivisicns of Cenozoic which are recognized are: Volcanics of pre-Esmeralda age, the Esmerlada formation consisting in large part of lake beds, of upper Miocene age, volcanics of late Esmeralda time, Pliocene lacustrine sediments, Pliccene andesites, basalt of late Pliocene or Pleistocene age and alluvium of Pleistocene and recent age. The Tertiary is unconformable on the Mesozoic. Thre major unconformities are recognized within the Tertiary; the oldest volcanics were deformed before the deposition of the Esmeralda, the Esmeralda was deformed before the extension of the andesites and a widespread erosion surface was developed upon the andesite and older rocks before the basalts were extruded.

Faulting is the dominant structural feature of the Tertiary rocks. The volcanics and sedimentary beds are tilted at angles of 20° or less but in general are nowhere highly folded. Pre-Tertiary rocks are everywhere highly folded and in places compressed and overturned. Overthrusting was observed at several localities. The major deformation has involved the Lower Jurassic sediments but not the plutonic rocks, and is believed to have occurred late in the Jurassic. The structure of the sedimentary rocks is independent of the intrusives. The intrusives in general truncate pre-existing folds. The trend of these structures is in general oblique or normal to the trend of the present ranges showing almost complete lack of concordance between structures of Tertiary and pre-Tertiary time.

The present topography is dominantly the result of faulting in 4 directions; movement having taken place at different times from a date prior to the upper Miocene up to the present.

The major faults show a rough pattern. Northerly faults dominate in the easterly portion of the area; northeasterly faults are found along the northern border; northwesterly faults, parallel to the Sierra scarp, are found in the west; and there is a small group of westerly faults in the southwest. This herringbone pattern is found too widely and is too pronounced to be accidental. It may be dependent on the major line of pre-Tertiary structure. The faults differ in age, but movement on the most recent faults seems in most cases to a revival along older fault lines.

For the faults of the oldest group, the evidence is weakest. Near its contact with the older rocks, the Esmeralda formation contains coarse fanglomerates which grade out into fine grained material towards the valley. This implies deposition in basins whose walls had considerable relief. Where

contacts of this type show alignment parallel to later more definite faulting and at the same time not in accord with the structure of the older rocks it is assumed they mark the approximate position of buried fault scarps along which there has been no revival of movement. Since the Esmeralda in places exceeds 1,000 feet, deposition in sinking basins is implied.

An old erosion surface is present in nearly all of the ranges. This is assumed to be of late Pliocene age. Faults which are truncated by this surface belong therefore to the first two groups.

The Pleistocene faults displace this older surface and consequently preserve their topographic expression. Those whose activities ceased in comparatively early Pleistocene time do not show the facetted spurs characteristic of the more recent faults, and the retreat of the range front from its original position is shown by the presence of a rock bench or pediment whose width and definition varies with the resistance of the rock.

The most recent faults have caused the type of range front most commonly associated with basin range structure. The streams crossing the scarp flow in narrow box canyons near the front with widening valleys headward. Stages of the faulting are in many places indicated by terraces in the canyons. The interstream areas present sharp facetted slopes reaching the main valley without the interposition of a pediment. Movement along individual scarps was variable. In the Toyabe range the northern streams cascade over rock to the edge of the range while those in the south are gravel choked at their mouths. Major movement on the Wassuk front seems to have been more recent than on the Toyabe because the greatest depression in the valley is close to the scarp while in the valley east of the Toyabe, it is nearly along the center.

The remnants of a broad bench, present at different elevations on the recent fronts of the Toyabe, Pilot, and Wassuk ranges, is evidence that there was a definite pause between early and later Pleistocene faulting.

In certain cases movement along the same fault line took place in opposite directions at different times and places. The clearest evidence of this is the fault extending northwesterly from the west front of the Pilot Range. Here, movement in Pleistocene time along the southern half had its downthrow on the west. The same fault continues diagonally across the Gillis range but without topographic expression other than the development of fault line valleys. Here the relations of granite and rhyolite indicate downthrow on the east. Since in the southern part the older faulting, if any, is masked by the later, it could not be certainly determined whether the newer faulting represents movement in a reverse direction to the older or whether this is an example of a hinged fault in which recent movement has been confined to the southern block.

There is a suggestion of similar action along the San Antonio and Toyabe range fronts. Here movement on both blocks seems to have been initiated in Pleistocene time, and hinge faulting is the more probable explanation.

In only a few cases can the absolute direction of movement be determined. The old erosion surface, which is our guide in estimating relative movement, must be used with caution as an absolute datum plane. There is no evidence that the region had free access to the sea or a humid climate in late Tertiary or Pleistocene times. Under conditions of inclosed basins and semi-aridity it is possible for a large area to be worn down to an old age topography dependent upon a base level far above the sea or upon several independent base levels at varying elevations. It is moreover likely that earlier regional uplift of which the Sierra gives evidence extended over a part of the Basin Range province.

Study of individual blocks, however, does suggest absolute upward movements for certain horsts and absolute depression for certain graben, at least during Pleistocene faulting.

In the earlier stage of the Pleistocene the Pilot range was elevated absolutely as a horst since the pediment on the east accords in elevation with the bench or hanging pediment on the west, and both are about 2,000 feet below the level of the old surface. If the movement was absolutely down on each side of the range it would require two simultaneous but unconnected faults of equal displacement.

On the other hand the more recent faulting confined to the west side of the range seems to have been absolutely downward, for the new scarp has a maximum height of 1,000 feet yet the bench and pediment are not tilted and there is no compensating recent fault on the east. Whether the downthrown block was rotated or whether the whole area between the recent Pilot and Wassuk faults is to be considered a graben was not determined.

The Pilot block therefore may be considered an absolutely elevated horst with later downward movement on one side and without rotation. The recent fault block of the Toyabe and Wassuk ranges however shows tilting of the old surface.

Although faulting is the dominant feature in the present ranges, there is also evidence of flexures of late Tertiary to Recent age. A detailed study of the individual fault blocks shows cases of faults dying out into flexures and much warping accompanying faulting. (*Authors' abstract.*)

Discussed by Messrs. BRYAN, STOSE, W. M. DAVIS, MATTHES, LAWSON, G. R. MANSFIELD, KEITH, and SPENCER.

392D MEETING

The 392d meeting was held in the Auditorium of the Department of the Interior March 26, 1924, President WRIGHT presiding, and 44 persons present. The secretary announced the election of Dr. WALTER R. SMITH, U. S. Geological Survey, and the resignation of Dr. PENTTI ESKOLA.

Program: CHARLES BUTTS.—*The Birmingham overthrust in central Pennsylvania.*

Discussed by Messrs. KEITH, STOSE, and SOSMAN.

F. E. MATTHES.—*Hanging side valleys of the Yosemite and the San Joaquin Canyon.* Detailed study of the physiographic features of the Yosemite region some years ago led the author to conclude that the hanging valleys from whose mouths pour the waterfalls for which the Yosemite is famed, belong to three separate sets situated at different levels one above another. Also, that these three sets are not of contemporaneous origin but are products of successive morphogenic events.

The highest and oldest set of valleys, it appears, was left hanging as a result of the rapid trenching of the main valley by the Merced River, when that stream was rejuvenated by the first great uptilting of the Sierra block, presumably early in the Pliocene epoch. The middle set was carved in the ensuing cycle of erosion and was left hanging in its turn by the renewed trenching of the main valley by the Merced in consequence of the second great Sierra uplift, presumably about the close of the Pliocene. The lowest set of hanging valleys was carved during the next cycle of erosion and was left hanging, apparently, as a result of the overdeepening and widening of the main chasm by the Pleistocene glaciers. The older hanging valleys have remained preserved owing to the exceedingly resistant nature of the massive granite which prevails in the Yosemite region.

The key to this analysis is found in the lower Merced Canyon which, although unglaciated, has a set of imperfect hanging valleys. This set, it was found by a careful reconstruction of the former profile of the Merced to which these valleys were graded, corresponds to the middle set of the Yosemite region. Unfortunately, a complete comparison between the Merced Canyon and the Yosemite region is not possible, owing to the fact that the metamorphic rocks through which the former is laid are much less resistant to erosion than the massive granite of the Yosemite region and are now so thoroughly dissected that no hanging valleys of the upper set remain preserved on them. Again, the comparison is unsatisfactory because the boundary between the granite and the metamorphic rocks happens to coincide with the extreme limit reached in the canyon by the Pleistocene ice. For these reasons it was deemed desirable to institute a comparison with the San Joaquin Canyon, which has passed through the same morphologic history but is carved in essentially massive granite through its length.

Inspection of the San Joaquin Canyon in 1921 and 1923 has revealed the existence throughout its unglaciated lower part and as far up in its glaciated middle part as the Pleistocene gorge cutting has progressed, of two sets of hanging side valleys that correspond in elevation to the two higher sets found in the Yosemite region. These features are in fact splendidly developed to within a few miles of the foothills, and the analysis made in the Yosemite region accordingly stands fully confirmed.

The lowest set of hanging valleys also is represented in the San Joaquin region, but there are some features in the lower part of the canyon that would seem to indicate that this set too is primarily of stream cut origin and only secondarily of glacial origin. Glacial erosion would thus seem to be minimized, but this is true only in the lower and middle parts of the canyon. In the upper parts, which were subjected to more frequent and more prolonged glaciation, the excavational effects produced by the ice are considerable. (*Author's abstract.*)

393D MEETING

The 393d meeting was held in the Auditorium of the Department of the Interior April 9, 1924, President WRIGHT presiding and 45 persons present. The question of place of meeting for the following year was discussed by Messrs. G. R. MANSFIELD, MENDENHALL, CAPPS, ALDEN, HEWETT, CROSS, and COLLINS. A rising vote showed 24 in favor of meeting at the Cosmos Club; no one voted to continue to use the Auditorium of the Department of the Interior.

Program: HAROLD T. STEARNS.—*Igneous geology of the Mud Lake Basin, Idaho.* The Mud Lake basin is situated in the northeastern part of southern Idaho and comprises an area of about 2,500 square miles. The area is bounded on the north by the Continental Divide of the Rocky Mountains, and on the east by Big Bend Ridge. The basin forms a part of the Snake River lava plain.

The purpose of the Mud Lake investigation was to determine the origin and supply of Mud Lake, a lake covering 31,000 acres of land which came into existence about 1900. The lake originated from irrigation on Egin Bench 20 miles to the east.

Thick beds of Triassic and Cretaceous sandstone were discovered along the, Continental Divide during the investigation.

Following the building of the Rocky Mountains, a cycle of erosion developed the Idaho peneplain. Upon this peneplain the first lava was extruded.

Some time during the Miocene the first volcanic eruptions began in the region. Eruption after eruption occurred and thick flows of rhyolite were extruded. These flows were very extensive and may have obliterated the entire Miocene landscape of the region. The acidic eruptions continued into the Pliocene for camel bones were found in the ash of one of the cones. If the age correlation is correct for the rhyolites of western Idaho, there has been a shifting eastward of the loci of eruption from Miocene to Pliocene time.

A few small basic eruptions occurred during this period.

In late Pliocene time another period of erosion began which culminated in the peneplain preserved on the top of Big Bend Ridge.

At the close of this period of erosion, andesitic lavas were extruded from numerous small vents along the foothills of the mountains. These eruptions were intermediate both in time and space between the basalt of the Snake River plain and the rhyolite of the adjacent mountains.

The Pleistocene and Recent were occupied by the pouring out of floods of basalt from single craters, crater chains, and fissures.

Three types of cones were described:

1. Scoria cones. About 150 were mapped. They range in height from 25 to 1,000 feet.

2. Dome-shaped basalt cones. Some of these cones are only 300 feet high but cover 100 square miles, indicating that several cubic miles of lava came from a single vent. About 30 were mapped. Morgan Crater, the largest crater in the region, is 1 mile in diameter and about 200 feet deep.

3. Tuff Cones. There were only 5 tuff cones found in the region. They are the Menan Buttes and occur in a straight line 7 miles long. They were probably due to basic magma which, in ascending to the surface through a fissure, came in contact with the water in the alluvial fan of Snake River.

Numerous surface features of the lava surfaces were described. About 30 lava tunnels were mapped. (*Author's abstract.*)

Discussion: F. E. Wright, G. R. Mansfield, W. C. Alden, F. E. Matthes, O. E. Meinzer, and R. B. Sosman.

C. W. Gilmore.—*The Dinosaur National Monument and its fossils.* In this paper a brief historical review of the establishment and work done at the Dinosaur National Monument, Utah, was presented, followed by an account of the operations carried on there by an expedition from the U. S. National Museum. Attention was directed to the fact that this fossil deposit is the most extensive and productive of any ever found in the Morrison formation. The character of the sediments and the manner of deposition of the dinosaurian fossils were briefly explained, and it was pointed out that the National Museum expedition was successful in having secured sufficient material for a good skeletal mount of *Diplodocus* that will exceed 80 feet in length with a height at the hips of over 14 feet.

In concluding this paper, slides and one reel of moving pictures were used to illustrate the methods employed in collecting these large fossil remains. (*Author's abstract.*)

394TH MEETING

The 394th meeting was held at the Cosmos Club, Wednesday evening, April 23, 1924, at 8 o'clock, President Wright in the chair and 33 persons present. The secretary announced the election of Stephen G. Mason to membership.

Program: H. E. MERWIN.—*Note on the hydrated sulphates of magnesia in hot springs.* In samples of hot springs deposits collected and analyzed by Dr. E. T. Allen four different crystalline substances were determined optically. Chemically, all seemed to be hydrates of magnesium sulphate, but only one such hydrate has been described optically as a mineral. Studies of the system $MgSO_4$-H_2SO_4-H_2O and of the thermal dehydration products of $MgSO_4$.-$7H_2O$ were carried on, and the tetra- and penta-hydrates found to be new minerals, and also the optical properties of the hexahydrate were determined (*Author's abstract.*)

H. D. MISER.—*A new areal geologic map of Oklahoma.* A new areal geologic map of Oklahoma to be printed in colors is being prepared by the United States Geological Survey in cooperation with the geologists in Oklahoma. The map compilation which was assigned to me consisted mostly in making use of available information from numerous sources; very little field mapping was done except during several field conferences with other geologists. Unpublished maps obtained from scores of commercial geologists and companies cover about one-third the State; unpublished maps from the Federal and State geological surveys cover the second third; and published maps cover only the last third. The new State map will therefore present new mapping for fully half the State. The total number of used maps that have been obtained from all sources is about 900.

Some of the most interesting features displayed by the new map are as follows:

1. The connection of the northern Oklahoma Pennsylvanian section with the Arbuckle section.
2. A great synclinal basin in the Permian Red Beds lying north of the Wichita Mountains.
3. A westward extension of the Wichita Mountain uplift into the panhandle of Texas.
4. An en echelon arrangement of the structural axes of the Wichita and Arbuckle mountains and of the intervening area.
5. A broad crescent-shaped pattern of the Boggy shale (Pennsylvanian) more than a hundred miles in length, with one point of the crescent touching the southwest end of the Ozark region and the other point touching the north side of the Arbuckle Mountains.
6. Numerous thrust faults with a total horizontal displacement of many miles in the closely folded rocks of the Ouachita Mountains.
7. Several long lines of en echelon faults in northeast central part of State.
8. A striking radial arrangement of the color patterns for the entire State, with the Arbuckles occupying the center of the hub. (*Author's abstract.*)

Discussed by Messrs. LAWSON, WHITE, MENDENHALL, SPENCER, and KEITH.

E. M. SPIEKER.—*Stratigraphy and structure of the Wasatch Plateau.* Discussed by Messrs. THOM, SEARS, REESIDE, SPENCER, and LAWSON.

C. WYTHE COOKE, *Secretary.*

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 OCTOBER 4, 1924 No. 16

ZOOLOGY.—*A new Chinese lizard of the genus* Eumeces. LEONHARD STEJNEGER, National Museum.

The *Eumeces xanthi* which Guenther described[1] in 1889 from Ichang, province of Hupeh, was based on material collected by Pratt, the type being in British Museum. Guenther described it as related to *E. skiltonianus*, having the dorsal scales "much broader" than the lateral and ventral ones. Seven years later he identified[2] specimens obtained by the Russian explorer Potanin near the town of Lifang-fu (August, 1894) and in the valley of the river Tung (April, 1894), both localities in high altitudes in western Szechwan, as *E. xanthi.*

The Chinese skinks of this genus are so similar in general appearance and the really important characters separating the species were at that time so little understood that the original description of this species is quite insufficient to determine exactly the status of other species from the same general region. It was therefore quite natural that Dr. Barbour in receiving a single specimen from Ichang, the type-locality, should identify it as *E. xanthi,* though apparently with considerable doubt, as he carefully recorded[3] the deviations of his specimen from the original description. Having recently had occasion to study the Chinese skinks, I was favored by Dr. Barbour with the loan of this specimen and was able to show that in reality it is a young *E. elegans.*

Two specimens (nos. 66736–7) recently received from Rev. D. C. Graham by the National Museum were collected by him at an altitude of 5–6000 feet near Luting Kiao, western Szechwan, the place where the road to Tatsienlu crosses the Tung River. As this is

[1] Ann. Mag. Nat. Hist. (6) 4: 220. 1889.

[2] Ann. Mus. Zool. St. Pétersbourg 1: 203. 1896.

[3] Mem. Mus. Comp. Zool. Cambridge 40: no. 4: 134. 1912.

almost certainly the identical locality whence came Potanin's specimens which Guenther himself had identified as *E. xanthi*, my first inclination was to identify them with this species, but on second consideration it was felt that the differences from Guenther's original description were too great to be reconciled. They showed some general similarity to a new species, *E. pekinensis*, recently described[4] by me from the province of Chili, 65 miles north of Peking. They differed, however, radically from the latter in the arrangement of the large temporal shields which, as I have first shown in the Herpetology of Japan (1907), is of prime systematic importance in this genus. On the other hand, the shape and relation of these shields were not recorded in the description of *E. xanthi*. I therefore had sketches prepared of the various styles of temporals represented in my series of Chinese *Eumeces*, including *E. quadrilineatus* and the Tung River specimens, and sent them, without names, to the curators in charge of the herpetological collections in British Museum and the Russian Academy of Sciences. Mr. H. W. Parker of the former, kindly sent a sketch of the type of *E. xanthi* showing the temporal shields to be identical with those of *E. quadrilineatus*, while of the latter, Mr. S. Czarewsky, returned the sketch of Graham's Tung River specimen with the notation that it "agrees entirely" with the Potanin specimens, which in addition he describes as having the median dorsal scales not broader or scarcely broader than the rest and as having on the back a median yellowish stripe. Thanks to the kindness of these gentlemen, all doubts as to the distinctness of the former have thus been cleared away, and I have no hesitation in naming and characterizing the new species as follows:

Eumeces tunganus, sp. nov.

Diagnosis.—Median dorsal scale rows not enlarged; two unpaired postmentals; a postnasal; 26 scales around the middle of the body; lower temporal of the second row with parallel upper and lower edges, the upper anterior corner cutting angularly into the upper temporal of the same row, soles nearly uniform granular with a few large tubercles near the heel.

Type locality.—Luting Kiao, where road to Tatsienlu crosses Tung River, western Szechwan, China; altitude 5000–6000 feet.

Type.—U. S. National Museum no. 66736; D. C. Graham, collector; August 9, 1923.

The type has one yellowish median dorsal stripe and two lateral ones; the smaller one (no. 66737), same locality and date, is without either dorsal or lateral stripes.

I am inclined to believe that the present species is more nearly related to *E. latiscutatus* (Hallowell) than to any of the other Chinese skinks.

[4] Occ. Pap. Boston Soc. Nat. Hist. 5: 120. July 21, 1924.

ENTOMOLOGY.—*North American Eucosminae, notes and new species (Lepidoptera).* CARL HEINRICH, Bureau of Entomology. (Communicated by S. A. ROHWER.)

In the present paper I am describing seven new species and four new varieties, adding two described species to our faunal list, reducing two species to the rank of varieties, sinking three species as synonyms, and transferring the generic position of three others. These changes are occasioned by the receipt of a large amount of additional material sent in for determination (chiefly by Dr. Wm. Barnes, E. H. Blackmore, and the Canadian National Museum) since the publication of my revision of the Eucosminae.[1]

Strepsicrates smithiana, Walsingham

Strepsicrates smithiana Walsingham, Proc. Zool. Soc. Lond., 1891: 506.

This West Indian species will have to be listed in our fauna, as Dr. Barnes has several specimens from Everglades, Florida (Reared "Apr. 8–15" and "Apr. 16–23" from larvae feeding on guava). A pair of these has been deposited in the National Collection. The males show no differences in genitalia or pattern from those of Dyar's *indentana.* The females are somewhat differently marked; *smithiana* has a narrow, rather strong shading of black scales along dorsal margin and termen of forewing, which is lacking in *indentana,* while *indentana* has a fine black streak from end of cell to apex, lacking in typical *smithiana.* Otherwise the two forms agree. I am therefore keeping the Dyar name, but reducing *indentana* to the rank of a variety.

Alar expanse.—12–14 mm.
Type.—In British Museum.
Type locality.—St. Vincent, British West Indies.
Food plant.—Guava.

Thiodia ornatula, new species

Palpus extending scarcely the length of the head beyond it; snowwhite. Face and forepart of head snow white; posterior part of head fuscous. Thorax blackish fuscous, more or less spotted with white; tegula blackish anteriorly, dull white behind. Forewing pale cream white marked with blackish fuscous and brown; a broken, outwardy angulate basal patch indicated by several irregular blackish fuscous lines extending from costa and dorsum, these not meeting (the patch broken longitudinally below costa); on outer half of costa four large pale brown geminate spots; a round brown apical spot and a narrow short brown streak along termen at middle; ocelloid patch consisting of two vertical metallic bars enclosing a blackish fuscous patch which expands above into a rather large blackish spot and merges into extensions of the brown geminations from costa; on dorsum bordering the inner margin of the ocelloid patch a rather large triangular blackish

[1] Bull. U. S. Nat. Mus. no. 123. 1923.

patch; cilia brownish, paler toward costa and with a narrow dark fuscous basal band above tornus; forewing, otherwise, of the whitish ground color; termen concave; veins 3, 4, and 5 somewhat approximate at termen. Hindwing pale smoky fuscous; cilia paler with a dark basal band; veins 3 and 4 short stalked.

Male genitalia similar in shape to those of *essexana* Kearfott, but slightly smaller and with neck of harpe more heavily haired.

Alar expanse.—12.5–15 mm.

Type.—In collection Barnes.

Paratypes.—Cat. no. 27247 U. S. N. M. Also in American Museum, Canadian National, and Barnes collections.

Type locality.—Oak Station, Pennsylvania.

Food plant.—Unknown.

Described from male type, 19 male and 1 female paratypes from the type locality bearing dates from June 21 to Aug. 15 (*F. Marloff*); 1 female paratype from New Brighton, Pennsylvania ("VII–20–07"); 1 female paratype from Wyoming County, Pennsylvania (*W. D. Kearfott*, "VI–17–06"); 3 male and 1 female paratypes from Pittsburgh, Pennsylvania (*H. Engel*, "VI–25–08"); 1 male paratype from Essex County Park, New Jersey (*Kearfott*, July 22); 1 male paratype from Plummer's Island, Maryland (*Busck*, Aug. 1903); and 1 male paratype from Chicago, Illinois (Sept. 1900). These specimens had been determined by Kearfott as *Laspeyresia gallaesaliciana* Riley and were in the Barnes and American Museum collections under that name.

A very distinct species, resembling *Epinotia nigralbana* Walsingham in color, and pattern, and like no other *Thiodia*.

Thiodia insignata, new species

Palpus extending the length of the head beyond it; greyish fuscous; inner side white. Face, head, and thorax greyish fuscous. Forewing whitish grey with dark greyish fuscous pattern marking and an ochreous shade below apex; a complete outwardly angulate dark basal patch further out on dorsum than on costa and with apex at vein 1b; from mid costa to vein 1b below end of cell a dark slanting half fascia from the end of which a very faint dark shade extends upward to sub apical costal spot; on dorsum near tornus and opposite extremity of fascia, a similar colored triangular dark spot; costa beyond middle with four greyish fuscous spots separated by white germinate dashes; ocelloid patch a group of seven black dots separated by three very faint vertical metallic bars; area above, suffused with ochreous; termen straight and decidedly slanting; veins 3, 4, and 5 not approximate at termen; cilia sordid whitish with a dark median shade. Hind wing pale smoky fuscous; cilia paler, with a broad dark median band; veins 3 and 4 united.

Male genitalia similar to those of *octopunctana* Walsingham.

Alar expanse.—19–20 mm.

Type.—In collection Barnes.

Paratype.—Cat. no. 27248 U. S. N. M. Also in American Museum.

Type locality.—Silverton, Colorado.

Food plant.—Unknown.

Described from male type and 1 male paratype from the type locality ("July 8–15" and "Aug. 1–7") and 1 male paratype from Chimney Gulch, Golden, Colorado (*Oslar*). I have also before me two males from Iditarod, Alaska ("June 22 and July 7, 1918," *A. Twitchell*) which appear to be the

same species. They are similar in color, markings and structure except that the dark shade connecting end of outer semifascia and subapical costal spot of forewing is darker and the apex of cucullus is a trifle more pointed. They possibly represent a distinct local race; but for the present may as well go under this name.

Closest to *columbiana* Walsingham; with similar pattern, but larger and darker and with different genitalia; the costa of harpe is straighter and the apex of cucullus more distinctly rounded.

Thiodia kokana (Kearfott)

Eucosma kokana Kearfott, Trans. Amer. Ent. Soc. **33**: 29. 1907.
Barnes and McDunnough, Check List Lepid. Bor. Amer. no. 7006, 1917.
Eucosma chortaea Meyrick, Ent. Mo. Mag. **48**: 35. 1912.
Hystricophora kokana Heinrich, U. S. Nat. Mus. Bull. 123, 259. 1923.
Thiodia sororiana Heinrich, U. S. Nat. Mus. Bull. 123: 263. 1923.

Mr. Meyrick has suggested to me the above synonomy which I was inclined to doubt, as the type (♀) of *kokana* and that of *sororiana* (♂) showed some slight differences in the shape of termen and in the approximation of veins 3, 4 and 5 on termen of forewing. Recently, however, we have received from Miss Annette F. Braun a pair (♂ and ♀) of authentic *kokana* from the type locality (Cincinnati, Ohio). These specimens showed the differences to be purely sexual and the tentative reference of *kokana* to *Hystricophora* an error.

Thiodia infrimbiana candidula, new variety

A pale Eastern race of *infimbriana*, distinguished by its snow white color and unmarked white forewing cilia. It lacks the olivasceous overcast of typical *infimbriana*. There is no trace of the semicircular dark shade above the ocelloid patch, so conspicuous in the latter, and the markings are fainter, in some specimens almost obsolete. The harpe of the male genitalia also has a cucullus more sharply pointed at apex.

Alar expanse.—15–18 mm.

Type.—In Canadian National Collection.

Paratype.—Cat. no. 27249 U. S. N. M. Also in Canadian National, American Museum, and Barnes collections.

Type locality.—Aweme, Manitoba.

Food plant.—Artemesia.

Described from male type 7 male and 1 femae paratypes from the type locality collected by *Norman Criddle* ("28–VII–1921", "3–VII–1921," "15–VIII–1921" and "23–VII–08"); 2 female paratypes from Cartwright Manitoba (*E. F. Heath*); and one male paratype from St. Anthony Park, Minnesota (labeled, "ties leaves of *Artemesia ludovicana*, Aug. 6").

This name will apply to the Manitoba and other eastern specimens which we have hitherto referred to *infimbriana* Dyar. Typical *infimbriana* is apparently limited to the Pacific coast.

Thiodia segregata, new species

Palpus, face, and head dull white; palpus extending the length of the head beyond it; grey toward apex. Thorax and gound color of forewing creamy or greyish white, due to a greyish ochreous shading at tips of scales; a pale rusty ochreous basal patch and median fascia and a similar dark shade toward apex faintly indicated; in some specimens the basal patch is fairly clear and angulate, with the apex at vein 1b, and farther out on dorsum than on costa; in others it is indicated only by a faint median or dorsal shade; median fascia a faint, straight, rather narrow band from mid costa to outer fourth of dorsum; ocelloid patch weak, consisting of three very faint, vertical metallic bars enclosing a varying number of small black dots, sometimes as many as nine, often altogether obsolete; termen concave; veins 3, 4, and 5 somewhat approximate at termen; cilia whitish, finely dusted with blackish grey. Hindwing pale smoky fuscous; cilia pale, with a dark basal band; veins 3 and 4 united.

Male genitalia as in *festivana* Heinrich.

Alar expanse.—11–12 mm.

Type.—In collection Barnes.

Paratypes.—Cat. no. 27250 U. S. N. M. Also in American Museum and Barnes collections.

Type locality.—Monachee Meadows, Tulare County, California.

Food plant.—Unknown.

Described from male type, 43 male and 2 female paratypes from the type locality (8000 ft., "July 26–23" and "Aug. 8–15").

Similar to *festivana* Heinrich; but paler and less distinctly marked. Possibly a local race of that species.

Eucosma giganteana minorata, new variety

A food plant variety, differing from typical *giganteana* in size and habit. The color and pattern are the same; but the moths are much smaller and the genitalia (male and female) are only half the size of those of *giganteana*, tho similar in shape and structure. The larvae of typical *giganteana* are borers in the roots of *Sylphium perfoliatum* while those of the new variety feed in the flower heads of *Sylphium gracile*. Such a difference in food habit within a species is not astonishing in the Olethreutidae, and in this case does not, I think, justify more than varietal separation.

Alar expanse.—17–19 mm.

Type.—Cat. no. 27251 U. S. N. M.

Type locality.—Liberty, Texas.

Food plant.—*Sylphium gracile.*

Described from male type and one male paratype from the type locality (July 29, 1922 and July 16, 1923); and one female paratype from Stowell, Texas (July 5, 1923) all reared by L. J. Bottimer of the Federal Horticultural Board.

Gypsonoma parryana (Curtis)

Argyrotosa parryana Curtis, Appendix, Ross Second Arctic Voyage, 1835, p. 75.

Omitted from my revision of the Eucosminae. Similar to *fasciolana* in pattern and genitalia; but with outer dark fascia of forewing disappearing before dorsum and with aedoeagus longer and more slender.

There are several specimens from Alaska in the Canadian National Collection.

Alar expanse.—18–19 mm.
Type.—Location unknown.
Type locality.—Arctic America.
Food plant.—Unknown.

Gypsonoma nebulosana (Packard)

Grapholitha nebulosana Packard, Proc. Bost. Soc. Nat. Hist. **11**: 61. 1866. Heinrich, U. S. Nat. Mus. Bull. no. 123: 261. 1923.
Epinotia nebulosana Fernald, in Dyar List N. Amer. Lepid., no. 5231. 1903.
Enarmonia nebulosana Barnes and McDunnough, Check List Lepid., no. 7155. 1917.

Through the courtesy of Nathan Banks I have been able to make a genitalia slide of Packard's type and place this species. It is nearly unicolorous brown, with genitalia like those of *fasciolana* Clemens; possibly a suffused dark variety of the latter, but without any trace of the whitish anti-median and post median areas so conspicuous on *fasciolana.*

I would correct here an error in my *Revision of the North American Eucosminae.* The actual type (*Packard* no. 607; M. C. Z. type no. 14312) is at Cambridge and not in the Fernald collection as I stated. Fernald's specimen is a paratype. There is an authentic specimen (♂) from Hopedale, Labrador ("27–VII–1922") in the Canadian National Collection.

Alar expanse.—19 mm.
Type.—In Museum Comparative Zoology.
Type locality.—Strawberry Harbor, Labrador.
Food plant.—Unknown.

Gypsonoma adjuncta, new species

Palpus, face and head white, dusted with grey. Thorax dark grey dusted with white. Forewing dark (blackish) grey with a white patch, somewhat streaked with grey, on costa beyond base, an irregular (more or less obscured) white blotch on mid dorsum and some white dusting near costa on outer third; an obscure blackish dot at end of cell and a faint black dot at apex; cilia grey dusted with white at tornus. Hind wing dark smoky fuscous; cilia paler, with a very slightly darker basal band.

Alar expanse.—12–15 mm.
Type.—Cat. no. 27252 U. S. N. M.
Paratypes.—In Canadian National and Blackmore collections.
Type locality.—Toronto, Canada.
Food plant.—Unknown.

Described from male type and one male paratype from the type locality ((Parish, "1–13" and "6–7–16") received through Edward Meyrick and one paratype from Victoria, British Columbia (*W. H. Carter*, "26–VI–21," Blackmore no. 473).

Similar to the European *incarnana* Haworth, but with anti median white area not a complete pale fascia (dark basal patch fusing at least at middle with median dark scaling), with post median area more heavily dusted (almost suffused) with grey scaling, with costal hook of harpe of male genitalia much shorter, and with basal opening of harpe larger and more evenly rounded. Possibly an American race of *incarnana*.

Proteoteras implicata, new species

Forewing olivaceous green, marked with black or blackish fuscous; an outwardly angulate, dark basal patch faintly indicated by irregular lines of blackish scales beyond base, strongest on basal fourth of costa; costa finely strigulated; from just beyond middle of costa a dark outwardly slanting half fascia more or less dusted with black, extending to upper outer edge of cell; from end of this a fine black line extending out and up toward apex and terminating in a rounded black spot before apex. Hind wing brownish fuscous; cilia slightly paler, with a dark basal band.

In male some fine black scaling on upper side of hind wing, on base of cell, and between veins 1a and 1b at extreme base of wing; on under side of hindwing along costa from base to outer fourth, and a very little along lower vein of cell at base; on under side of forewing on basal third of costa and on upper and below lower veins of cell at extreme base; also on extreme posterior lateral margins of thorax and on outer side of hind tibia and outer surfaces of all femora.

Male genitalia with 2 or 3 heavy, flat spines from outer surface of harpe, and with entire neck of harpe from outer margin of basal opening to cucullus, densely spined; socii long and rather slender, with short hair pencils; general shape as in *aesculana*.

Alar expanse.—11–15 mm.

Type.—In Barnes collection.

Paratype.—Cat. no. 27253 U. S. N. M. Also in American Museum and Barnes collections.

Type locality.—Everglades, Florida.

Food plant.—"Bush Ash."

Described from male type, 3 male and 4 female paratypes from the type locality labeled, "ex larva in stems of Bush Ash, Apr. 16–23"; and one male paratype from La Chorrera, Panama (*Busck*, May 1912).

Similar to *aesculana* Riley; but with different genitalia and different sex scaling in male.

Exentera senatrix, new species

Palpus, face, head and thorax dark ashy grey. Forewing grey, the pale areas ashy grey with a faint bluish tint, the dark markings blackish fuscous; a dark basal patch somewhat broken on dorsum at base by pale scaling and fusing above cell with a similar dark shade from mid costa; at lower outer angle of cell a small blotch of blackish scaling; outer third of costa with three obscured dark geminations; costa otherwise very faintly marked with fine pale gemination; ocelloid patch obscure, two vertical bars enclosing 3 or 4 very short black dashes; forewing, otherwise, ashy blue grey; termen notched at veins 3–5; veins 3, 4 and 5 closely approximate at termen; 7 and 8 short stalked or connate; cilia dark ashy grey, paler toward tornus. Hindwing pale smoky fuscous; cilia paler, with a dark basal band.

Male genitalia similar to those of *improbana* Walker.

Alar expanse.—19–21 mm.

Type.—In Barnes collection.

Paratypes.—Cat. no. 27254 U. S. N. M. Also in American Museum and Barnes collections.

Type locality.—Paradise, Cochise County, Arizona.

Food plant.—Unknown.

Described from male type, one male and 7 female paratypes from the type locality, dated, "Mch. 8–15" and Apr. 1–7").

A rather striking species with very narrow forewings. Close to *improbana* but apparently distinct.

Epinotia cruciana (Linnaeus)

Two species, *Sciaphila direptana* Walker and *Sciaphila vilisana* Walker, described[2] from St. Martin's Falls, Albany River, Hudson Bay, were omitted from my revision. Judging by the descriptions and Knight's figures in the American Museum they are both synonyms of *E. cruciana* (Linnaeus) and should for the present, at least, be so referred.

Epinotia cruciana lepida, new variety

A small dark reddish brown variety with pale anti and post median metallic bands more or less obscured. Palpus sordid whitish, shaded with fuscous towards apex. Face and head whitish ochreous shaded with fuscous. Thorax and forewing dark reddish brown, in some specimens with a somewhat leaden luster on extreme base of wing and over thorax; from costa at $\frac{1}{3}$ to mid dorsum a pair of narrow, irregular metallic lines, more or less obscured and sometimes enclosing a pale ochreous shading; on outer third of costa three or four whitish or ochreous geminate marks (very faint in some specimens) from which extend three irregular nearly parallel metallic lines, two to tornus, and one to termen below apex, the last often obsolete or much obscured; cilia leaden fuscous with a pale shade toward apex. Hindwing smoky fuscous; cilia paler, with a dark basal band.

Genitalia as in typical *cruciana* except somewhat smaller.

Alar expanse.—11.5–12 mm.

Type.—In Barnes collection.

Paratypes.—Cat. no. 27255, U. S. N. M. Also in American Museum and Barnes collections.

Type locality.—Mount Washington, New Hampshire.

Food plant.—Unknown.

Described from male type, 21 male and 2 female paratypes from the type locality ("4000 ft. "July 24–31" and "Aug. 1–7"). A distinct, local, dwarfed variety.

Epinotia cruciana russata, new variety

A unicolorous form with sordid whitish ochreous palpus and head, and rust red thorax and forewing. In some specimens there is a very faint indication of a darker semi-fascia from mid costa to tornus, but in most this is not distinguishable. The leaden streak along costa from base to middle,

[2] Cat. Lepid. Heter. Brit. Mus. 28:338. 1863.

so characteristic of the species, is strongly marked; forewing cilia faintly shaded with leaden fuscous; a short, narrow, vertical leaden bar above tornus. Hindwing pale smoky fuscous, somewhat whitish towards base; cilia whitish, with a dark basal band and a faint dark median shade.

Genitalia as in typical *cruciana.*

Alar expanse.—15–16 mm.

Type.—Cat. no. 27256 U. S. N. M.

Paratypes.—In National Museum and Blackmore collections.

Type locality.—Victoria, British Columbia.

Food plant.—Unknown.

Described from male type and 2 male paratypes from the type locality (*E. H. Blackmore*, "24–VI–23," "25–VI–23" and "21–VII–23"); and one male and one female paratype from Brentwood, British Columbia ("14–VII–23" and "30–VI–23," *Blackmore*).

Epinotia seorsa, new species

Antennae whitish; in male finely pubescent. Palpus triangular, strongly porected, extending three times the length of the head beyond it; outer side purplish red or reddish ochreous; upper edge and inner side sordid whitish, sometimes with a slight greyish dusting. Face and head sordid whitish. Thorax rust or rosy red somewhat shaded with sordid ochreous white at middle. Forewing rust color (in some specimens red rather than ochreous, in others quite pale) with a faint rose purple suffusion towards apex; on dorsum near base an obscure outwardly projecting angulate semi-lustrous leaden or purplish fuscous patch, forming the dorsal remnant of an incomplete basal patch; from mid costa to just beyond middle of dorsum a similar colored fascia, rather broad for most of its length but sharply tapering at costal and dorsal extremities; beyond this a narrow outwardly curved dark line from outer third of costa to tornus; and beyond this an occasional faint obcure dark line or two from costa, disappearing near termen; in some specimens there is an irregular faint pale shading along dorsum from base to outer fifth, but this is normally lacking; cilia rosy or rust color dusted with leaden scales towards tornus. Underside of forewing with pale costa and with rest of wing more or less suffused with leaden scaling; the pattern markings, especially the fascia and post median line, darkest and rather strongly marked. Hindwing whitish mottled with fuscous; cilia whitish, with dark basal band.

Male genitalia with uncus strong, undivided, tip slightly swollen; harpe as in *infuscana* Walsingham but not so broad towards base; aedoeagus moderately long, straight and slightly tapering toward apex; cornuti a dense cluster of slender spines half as long as aedoeagus.

Alar expanse.—18–20 mm.

Type.—Cat. no. 27257 U. S. N. M.

Paratypes.—In National Museum, Canadian National Museum, Blackmore, and Barnes collections.

Type locality.—Vavenby, British Columbia.

Food plant.—Unknown.

Described from male type ("16–IX–1922, *Theo. A. Moilliet, Blackmore* no. 145"); one male and one female paratype from Victoria, British Columbia ("10–9–03" and "27–9–03"); one female paratype from Duncans, Vancouver Isl., ("22–9–12," *Hanham*); one female paratype from Quamichau Lake, Vancouver Island (*Hanham*, "*Blackmore* no. 665); one male paratype from

Truckee, California ("Oct. 8–15"); and one female paratype without locality label but bearing Blackmore's no. 876 and presumably from British Columbia.

A distinct species close to *septemberana* Kearfott and *vagana* Heinrich.

Hystricophora taleana (Grote)

Grapholitha taleana Grote, Can. Ent. **10**: 54. 1878. Heinrich, U. S. Nat. Mus., Bull. no. 123: 260. 1923.
Thiodia taleana Fernald, in Dyar List N. Amer. Lepid., no. 5182. 1903.
Eucosma taleana Barnes and McDunnough, Check List Lepid, Bor. Amer., no. 7071. 1917.

Under Grote's name the Canadian National Collection has several specimens from Aweme, Manitoba, agreeing with specimens from Kansas and Iowa which we had under *ochreicostana* Walsingham. If the determination is correct—and there seems no good reason to doubt it—*ochreicostana* and *taleana* are conspecific. Walsingham's name, however, may be retained as a racial designation for the Rocky Mountain and Western specimens, as these differ somewhat in both pattern and genitalia from those from the plains country; *ochreicostana* has broader harpes than *taleana* and a yellow shading on base of costa of forewing lacking in the latter form. Otherwise the genitalia and patterns agree. I am keeping *ochreicostana*, therefore as a variety of *taleana*.

Alar expanse.—15–18 mm.
Type.—In British Museum.
Type locality.—Illinois.
Food plant.—Unknown.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE BIOLOGICAL SOCIETY

664TH MEETING

The 664th meeting was held in the lecture hall of the Cosmos Club March 15, 1924, at 8 p.m., with Vice President OBERHOLSER in the chair and 34 persons present.

Under *Short Notes*, H. C. SKEELS exhibited a copy of the recently published "Standardized Plant Names" and inquired whether the practice followed in that work of ending all personal specific names in the genitive with a single *i* was likely to be adopted by botanists generally. The subject was discussed by Messrs. WETMORE, COVILLE, OBERHOLSER, and HITCHCOCK. Dr. OBERHOLSER stated that the contraction of the termination to a single *i*, which was followed at one time by the A.O.U., has now been abandoned by that body.

R. W. SHUFELDT read letters from foreign ornithologists referring to the specimen of *Archaeopteryx* in the Berlin Museum and to specimens of the Labrador Duck.

S. F. BLAKE reported that a flock of Purple Grackles, numbering between 3000 and 5000, is roosting at night in the southeast corner of the Soldiers'

Home grounds. R. W. SHUFELDT reported that during the winter a number of frozen Starlings had been brought to him from their roosting place in the southwest corner of the Soldiers' Home grounds.

F. V. COVILLE: *Grossularia echinella, a new species of gooseberry from Florida* (illustrated by specimens). The speaker described his discovery of a new species of *Grossularia* a few weeks ago in northern Florida. This plant, which is related to *G. curvata*, but very distinct, is the first species of the genus to be found in Florida.

O. E. SETTE: *Conservation studies on California sardines.* The economic problems facing the world with its ever increasing population consist largely of the production of foods and the development of the energy needed to make them available to the consumer. The production of foods is dependent upon the productivity of the soil, the forests, and the fisheries, and it is the conservation of these resources that is dependent entirely upon the biologist for the information that proper administration requires.

In the case of the California sardine fishery, the problem is to administer the resources in such a way that the interest only is used, leaving the capital intact. The program of the state is that of allowing unlimited exploitation at the same time that a competent scientific staff is collecting and analyzing data which should determine the effect of such commercial fishing. This consists of collecting such statistics on landings and units of gear employed and in the analyzing of them in such a fashion as will show the return per fishing unit from year to year. Supplementing this, the staff is making such studies as will allow the distinction between natural fluctuations in abundance and those fluctuations due to the intensity of commercial fishing. These consist of studies in age and rate of growth. The size-frequency methods are being used instead of the more common method of scale determinations. This is done because the scales of the sardine in California are quite illegible, and the size-frequency constitutes a method into which personal interpretation does not enter, and at the same time provides a vast amount of material on the size-composition of the population, which is useful in the determination of the existence of such phenomena as size or age dominance. The present indications are that the size-dominance is present, though to a less degree than was found in the case of the Norwegian sea herring.

These studies have also had a by-product importance to the trade, namely, that of predicting sizes which will be present in large portions in future years. If allowed to proceed to its natural conclusion, this program will evaluate most of the factors in the life history of the sardine and will be a contribution of great importance in maintaining this and other fishery resources.

O. P. HAY: *Distribution of vertebrates in the Pleistocene of North America* (illustrated). The speaker outlined the stages into which the North American Pleistocene is divided and showed their distribution by maps. Illustrations of some of the more important vertebrates were thrown on the screen and details of their occurrence were mentioned. The localities at which remains of the larger groups have been found were shown on distribution maps.

665TH MEETING

The 665th Meeting was held in the lecture hall of the Cosmos Club March 29, 1924, at 8:05 p.m. with Vice President OBERHOLSER in the chair and 95 persons present.

E. P. KILLIP: *Botanical exploration in Colombia* (illustrated). As a part of a plan for the botanical exploration of northern South America an expedition went to Colombia in 1922 to collect plants and study the distribution of vegetation. Special attention was given to the flora of the Western Cordillera and the western side of the Central Cordillera. In order to study the north-south distribution and to compare the flora of the two ranges, bases were established at northern, central, and southern points on each cordillera.

Plant life in Colombia naturally varies greatly with altitude. Four zones of vegetation may be recognized: (1) Tropical, sea-level to about 5000 feet; (2) subtropical, 5000 to 9500 feet; (3) temperate, 9500 to 12,000 feet; (4) paramo, 12,000 feet to snow line.

Because of the heavy rain-fall on the Pacific coast the forest is here extremely dense, though because of the configuration of the mountains dry "pockets" frequently occur where cacti and other xerophytic plants grow. Palms are particularly striking in the Cauca valley and along the Quindiu trail. Among the characteristic plant groups of the Subtropical and Temperate zones are *Bomarea, Monnina, Passiflora,* Gesneriaceae, Lobeliaceae, orchids and ferns. Plants of the bleak Panamo Zone are usually brilliantly flowered and densely clothed with hairs. Conspicuous plants of this zone are the frailejones (*Espeletia*), and other composites, lupines, and lycopodiums.

About 23,000 specimens were collected, most of which were dried over charcoal fires. Much of the success of the expedition was due to the assistance given by the Governmental and Departmental officials as well as by private citizens. The hospitality of the Colombian people was greatly appreciated by members of the expedition. Discussed by A. S. HITCHCOCK.

N. A. COBB: *Two Blue Jays—Jack and Jill—and their home life* (illustated). The speaker gave an intimate account, illustrated by colored lantern slides, of the activities of a pair of blue jays that raised a brood of young in a tree close to his house at Falls Church. The ingenious devices to obtain an insight into their home life were described and illustrated by numerous photographs. The paper will appear in "Nature Magazine."

666TH MEETING

The 666th meeting was held in the lecture hall of the Cosmos Club April 12, 1924 at 8:05 p.m., with Vice-President ROHWER in the chair and 50 persons present. New members elected: W. W. DIEHL, Dr. W. H. RICH, O. E. SETTE, Miss MARY VAN METER, and Dr. J. R. WEIR.

Under *Short Notes*, M. K. BRADY reported his discovery of a four-toed salamander coiled about its eggs in Rock Creek Park. The species is new to the D. C. fauna.

Dr. T. S. PALMER inquired if members of the Society had observed box turtles this spring. Some captive adults in his possession have not yet emerged, but young ones, which did not bury themselves last fall and had to be pushed into the ground, have come out.—Discussed by A. WETMORE.

Dr. C. W. STILES reported that in experiments carried on by him it has been found that typhoid germs can live in the soil at least 106 days.

A. S. HITCHCOCK (presidential address): (a) *Remarks on the scientific attitude;* (b) *Botanizing in Ecuador* (illustrated); (c) *How to aid the Biological Society.* (*a*) A plea was made to scientists to meet with open-mindedness (the scientific attitude) questions in politics, economics, and religion. (*b*)

Collections were made at Guayaquil and several other places on the Coastal Plain, and at Huigra, Ambato, Urbina, and Quito, on the railroad from Guayaquil to Quito. Trips were made overland to Ibarra and Tulcan to the north, to Portovelo (a gold mine near Zaruma), Loja, and Cuenca to the south, and to Baños and Mera in the Oriente. Pichincha (near Quito) and Chimborazo were visited for alpine plants. About 2000 numbers of flowering plants were obtained. (*c*) The finances of the Society were briefly discussed. (*Author's abstract.*)

667TH MEETING

The 667th meeting of the Biological Society was held in the lecture hall of the Cosmos Club April 26, 1924, at 8:00 p.m., with President GIDLEY in the chair and 61 persons present. The President announced the appointment of the following trustees for the permanent funds of the Society: T. S. PALMER (3 years), H. C. OBERHOLSER (2 years), A. S. HITCHCOCK (1 year). New members elected: Dr. ALEXIS M. BAGUSIN, M. W. TALBOT.

Under *Short Notes*, Dr. T. S. PALMER reported that one of his adult box turtles has now come out. When digging their winter holes, he found that box turtles dig out the ground with their hind feet and thus move down gradually backward. Dr. P. B. JOHNSON reported that a box turtle which hibernated under dead leaves in his yard apparently backed into its hole. Dr. E. D. BALL reported that certain western turtles dug in backwards.

M. K. BRADY reported that he had found all three of the local lizards under one log in Fairfax County. After the close of the meeting, specimens of these lizards were exhibited.

A. S. HITCHCOCK inquired whether elephants use the trunk in a right or left-handed fashion. H. C. OBERHOLSER stated that it has been reported that birds always took a right-handed flight into the nest box. E. A. GOLDMAN said that most reindeer in Alaska mill clockwise, except for small groups which mill anti-clockwise. P. B. JOHNSON inquired whether this might be due to a lack of symmetry in the body.

AUSTIN H. CLARK: *Animal flight* (read by H. C. OBERHOLSER). The economic advantages of flight were first described, and the number of the various flying creatures given. The animals that can fly, or at least glide through the air, amount to nearly two-thirds of all the species known, and among land-living animals about three-fourths. These include, in numerical order, insects, birds, mammals, fishes, lizards, snakes and mollusks, with perhaps a crustacean and a frog. The flight of birds was taken up in detail and described, then the flight of bats, the gliding flight of mammals and of reptiles, and the flight of insects. The structures serving for flight were considered. The animals which, without special flying organs, are habitually wafted about by the wind, like many spiders and the young larvae of certain moths, were taken up, followed by those which, like the cobras, the frilled lizard, and many leaping mammals, have broad processes or tufts of long hairs which serve to minimize the danger from a fall by increasing the air-resisting surface. Lastly the flying creatures in the sea were discussed, the flying fishes and the flying squid. The flight of the last named was described from personal experience with them off northwestern Africa; when above the surface of the sea they are easily distinguished from the flying-fishes by the fact that a company always keeps together in close formation, and their flight is shorter. (*Author's abstract.*) Discussed by E. A. GOLDMAN, T. S. PALMER, A. S. HITCHCOCK and H. C. OBERHOLSER.

W. H. RICH: *Migration of salmon in the Alaska Peninsula region* (illustrated). The red salmon fishery located in Bristol Bay and along the Alaska Peninsula is one of the most valuable of the fishery resources of the United States. On account of extensive exploitation they were in real danger of depletion when the Alaska Fishery Reservations were established some two or three years ago. Administration of these is vested in the Secretary of Commerce acting through the Bureau of Fisheries. In order that regulations may be adequately based the Bureau has undertaken an extensive investigation of the various phases of the life history of these fish. Of especial importance has been the extent, direction, and rate of the oceanic migrations of the fish, with particular reference to the relationship of the fish taken in Bristol Bay to those taken near the extremity of the Alaska Peninsula. In an effort to solve this problem the Bureau has, during 1922 and 1923, tagged 14,000 red salmon, mainly in the region south of the peninsula but close to the extremity.

The results of these experiments have shown conclusively that the great bulk of the fish taken near the end of the peninsula and along the southern shore of the peninsula as far east as the Shumagin Islands belong to the Bristol Bay run. Their home streams are located in the Bristol Bay district and they are on their return migration to those streams from which they came, at the time they are taken commercially. Apparently the feeding grounds of these salmon during their life in the ocean is along the continental shelf of the north Pacific. Evidence is available which shows that the fish south of the peninsula pass through Isanotsky strait on their way to Bristol Bay. The rate of travel is approximately 20 miles per day during the early part of the season but this increases during the season until the rate is nearly double this toward the end of the season, the latter part of July.

In addition to the migration to Bristol Bay some of the salmon are bound to local streams along the southern shore of the peninsula and, to a less extent, to local streams along the northern shore. An interesting feature of this local migration is that the fish bound for these local spawning grounds apparently school separately from those bound for Bristol Bay. This is particularly indicated by the fact that in Morzhovoi Bay, the first large indentation of the southern coast of the peninsula east of Isanotsky Strait, the fish tagged along the western and northern shores of the bay were predominately Bristol Bay fish while those tagged along the eastern shore during the latter part of the season went mainly to local spawning grounds to to the eastward. A few of the fish tagged in the region about the Shumagin Islands went eastward as far as Chignik, Kodiak, and Afognak Islands and Cook Inlet. (*Author's abstract.*)

S. F. BLAKE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

E. F. PHILLIPS, Apiculturist of the Bureau of Entomology, has accepted a position as Professor of Apiculture in the New York State College of Agriculture at Cornell University, Ithaca, N. Y., and assumes his new duties October 1. J. I. HAMBLETON, of the Bureau of Entomology, will have charge of the Bee Culture Investigations of the Bureau.

Dr. F. M. WALTERS, JR., resigned from the Bureau of Standards on June 30 to become Professor of Experimental Physics in the Carnegie Institute Of Technology, Pittsburgh, Pa.

Dr. H. M. AMI, of Ottawa, Canada, a member of this ACADEMY, has just returned home from a five weeks stay in Europe where he attended the British Empire Mining Congress at Wembley. Later he visited Montières, St. Acheul, Cagny, Bovès, Belloy, and other prehistoric sites in the vicinity of Amiens and Abbeville in the Somme valley, and followed up his recent work in Seine and Marne and in the Dordogne country where he obtained further evidence as to life and culture in the New as well as in the Old Stone Age. On his return to Canada Dr. AMI attended the British Association Meeting in Toronto and read two papers: one in Section C (Geology) *Problems in the Palaeozoic Succession of Eastern Canada*, the other in Section H (Anthropology) *On recent discoveries in prehistory.*

Dr. GREGORY BREIT, of the University of Minnesota, joined the staff of the Department of Terrestrial Magnetism, Carnegie Institution of Washington as mathematical physicist, July 1.

Professor H. PITTIER, connected for twenty years with the U. S. Department of Agriculture and now director of the Commercial Museum at Caracas, Venezuela, recently received from the French Government the ribbon of Officier de l'Instruction publique, in recognition of his work on the botany, geography, and ethnology of Central and South America.

The Physics Club of the Bureau of Standards announces a course of 60 lectures by Dr. P. R. Heyl on *The fundamental concepts of physics in the light of modern discovery.* These lectures are to be given at 4:30 p.m. on Mondays and Thursdays of each week beginning September 29. All scientific men in the city who are interested in this course are requested to get in touch with F. M. Defandorf, Secretary of the Physics Club, Bureau of Standards.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 OCTOBER 19, 1924 No. 17

MATHEMATICS.—*A straight line chart for the solution of spherical triangles.* F. E. WRIGHT, Geophysical Laboratory.

A straight line chart for the solution of a spherical triangle, in which two sides and the included angle are given, has been in use for many years. In 1891 M. d'Ocagne[1] published a straight line chart for the solution of the equation for the spherical distance between two points on a sphere whose latitudes and longitudes are known

$$2 \cos c = (1 + \cos L) \cdot \cos(a - b) - (1 - \cos L) \cdot \cos(a + b)$$

in which c is the spherical distance, L, the difference in longitude, and a and b are the latitudes. This chart was reproduced in 1919 by Peddle[2] who derived it by the general method of determinants. In 1917 Littlehales[3] derived, independently and by still another method, the same chart for the solution of the same equation expressed, however, in haversines

$$(\text{hav } a = \sin^2 \frac{a}{2} = \frac{1 + \cos a}{2})$$

and of the form

$$\text{hav } z = \text{hav } (CoL - PD) + \text{hav}(CoL + PD) - \text{hav}(CoL - PD) \cdot \text{hav } t$$

in which z is the zenith distance, CoL, the colatitude, PD, the polar distance, and t, the hour angle. The Littlehales' chart is published

[1] Nomographie. Les calculs usuels effectués au moyen des abaques. Essai d'une théorie générale. Paris. 1891; Traité de nomographie. Paris. 327. 1899. (abaque de la distance sphérique). See also M. Collignon, Note sur la détermination de l'heure du passage du Soleil dans un plan vertical. Journ. de l'École Polytechnique, sér. 2, 4: 123. 1898.

[2] J. B. Peddle, The construction of graphical charts. New York. 149–151. 1919.

[3] G. W. Littlehales, Altitude, azimuth, and hour angle diagram. Proc. U. S. Naval Institute 43: 2541–2546. 1917.

by the Hydrographic Office of the U. S. Navy[4] as a separate sheet measuring 56.8 cm. (22.4 inches) on a side, and serves exceedingly well the purpose for which it is intended.

It has, however, apparently not been realized heretofore that this chart, properly labeled, is competent to solve not only the case of an oblique spherical triangle in which two sides and the included angle are given and the third side is sought, but also any spherical triangle for which any three of its six angles are given and the other three are sought. To show how this can be done and to direct attention to the usefulness of this chart in problems of spherical trigonometry is the purpose of this note.

The three fundamental equations of spherical trigonometry are

$$\sin a : \sin b = \sin A : \sin B \qquad \text{(sine formula)} \quad (1)$$

$$\left.\begin{aligned} \cos a &= \cos b \cdot \cos c + \sin b \cdot \sin c \cdot \cos A \\ \cos A &= -\cos B \cdot \cos C + \sin B \cdot \sin C \cdot \cos a \end{aligned}\right\} \text{(cosine formulas)} \quad \begin{aligned}(2)\\(3)\end{aligned}$$

in which a, b, c are the sides, and A, B, C are the solid angles opposite a, b, c respectively, of the spherical triangle. Other equations of similar form are derived from these equations by cyclical transposition of the letters in the usual manner.

The cosine formulas can be rewritten in the form[5]

$$2 \cos a = [\cos(b - c) - \cos(b + c)] \cdot (1 + \cos A) + 2 \cos(b + c) \quad (2a)$$

$$2 \cos A = [\cos(B - C) - \cos(B + C)] \cdot (1 + \cos a) - 2 \cos(B - C) \quad (3a)$$

which contains only cosine functions and from which the cosine chart is easily derived. In equation (2a) let $\cos a = y$, $1 + \cos A = x$, $\cos(b - c) - \cos(b + c) = m$, and $\cos(b + c) = n$; the equation reduces then to the form

$$y = \frac{m}{2} \cdot x + n$$

which is that of a straight line in rectangular coördinates. The line passes through the points: $x = O$, $y = n = \cos(b + c)$; and $x = 2$, $y = m + n = \cos(b - c)$. To construct the chart let O be the origin of coördinates; draw on the zero ordinate a cosine scale for the values

[4] Sheet no. 2776. Published June, 1917, at Washington, D. C. Plate 1 which accompanies this paper is a reproduction, on a reduced scale, of this chart. The scales, however, have been relabeled and other scales added. It is a pleasure for the writer to express herewith his indebtedness to Dr. G. W. Littlehales of the U. S. Hydrographic Office for permission thus to reproduce the chart.

[5] Expressed in haversines the cosine equations read

$$\text{hav } a = \text{hav}(b+c) + \text{hav}(b - c) - \text{hav}(b+c) \cdot \text{hav } A$$

$$\text{hav } A = \text{hav}(B+C) + \text{hav}(B - C) - \text{hav}(B+C) \cdot \text{hav } a$$

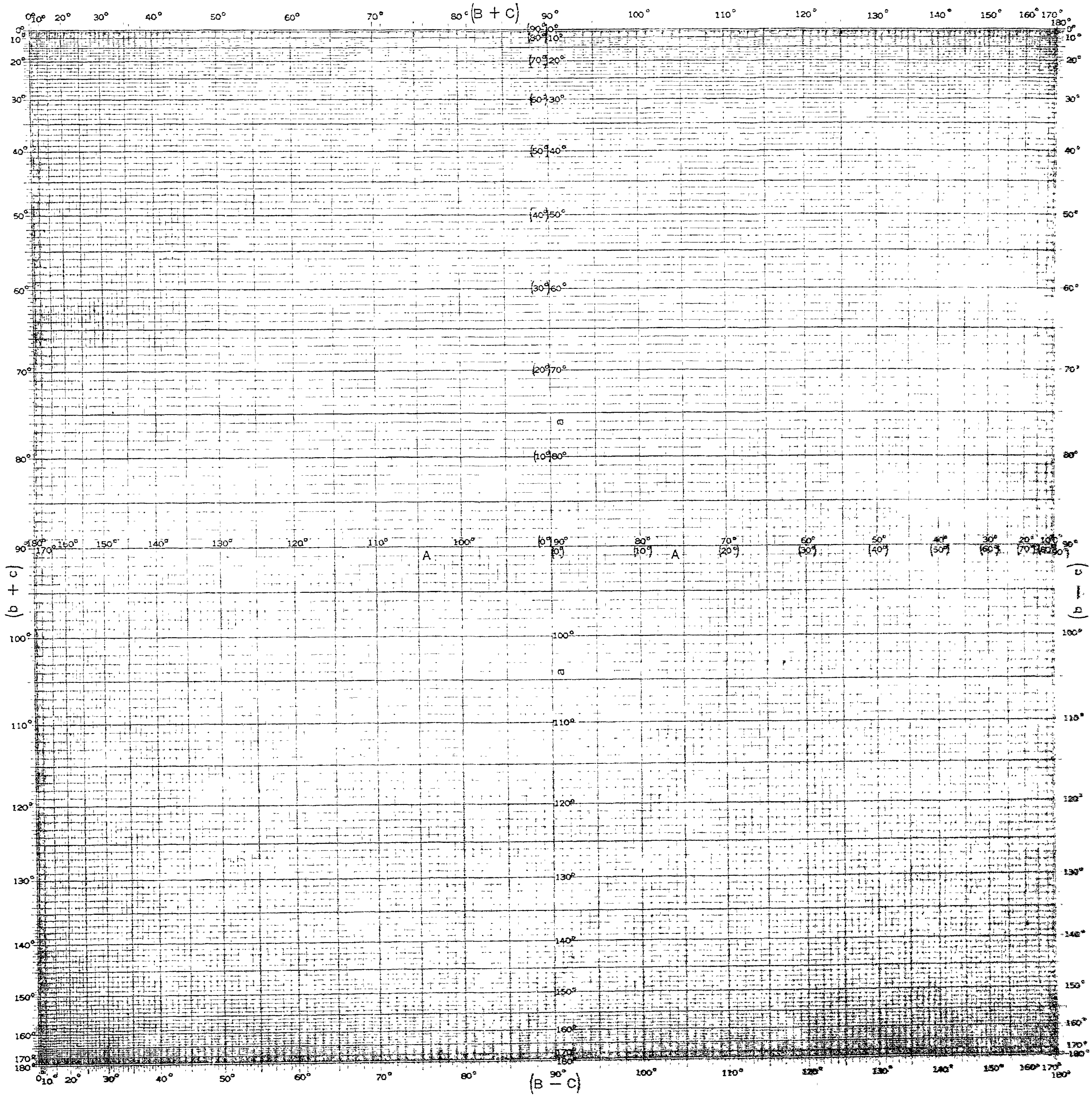


Plate 1. On this plate, which is a reproduction of sheet No. 2776 of the U. S. Hydrographic Office but with relabeled and additional scales, the scales of figs. 3 and 4 have been combined into one diagram, which is made to serve both as a cosine chart and as a sine chart, thus rendering it capable of solving any spherical triangle in which any three of the six elements are given; sought are the three remaining elements. The mode of construction depends on the elements given. For the six possible cases the constructions are described in the text and also under figs. 1 to 4.

$\cos(b + c)$; draw on the ordinate, NQ, at $x = 2$, a cosine scale to represent the values $\cos\,(b - c)$; along the x-axis, OQ, draw a cosine scale to represent the values $(1 + \cos A)$, as indicated in figure 1. To solve a spherical triangle in which b, c, and A are known, pass a straight line through the points L and N, for which $LO = \cos(b + c)$ and $NQ = \cos(b - c)$. For the point P on this line $PR = \cos a = y$, $OR = 1 + \cos A = x$ and from the similarity of the triangles NML and PSL we have

$$\frac{NM}{ML} = \frac{PS}{LS} \text{ or } \frac{\cos(b-c) - \cos(b+c)}{2} = \frac{\cos a - \cos(b+c)}{1 + \cos A}$$

which is identical with equation (2a). To solve equation (2a) by means of the chart (plate 1) pass a straight line through the points $(b + c)$ on the left side of the chart and $(b - c)$ on the right hand side and find the ordinate $PR = \cos a$ (labeled a) which passes through the abscissa $OR = 1 + \cos A$ and is labeled simply A.

For equation (3a) the mode of construction is similar to that for (2a) except for the signs of the angles. If, in equation (3a), $\cos A = y$, $1 + \cos a = x$, $\cos\,(B - C) - \cos\,(B + C) = m$, and $\cos\,(B - C) = n$, the equation reduces to the form

$$y = \frac{m}{2}\,x - n$$

which represents a straight line passing through the points $x = O$, $y = -n = -\cos(B - C)$ and $x = 2$, $y = -\cos(B + C)$. The graphical solution is illustrated in Fig. 2, in which $DT = \cos(B - C)$ $HG = \cos(B + C)$, $TK = 1 + \cos a$ and $KP = -\cos A = \cos\,(180° - A)$. In the similar triangles DEP and DFG we have

$$\frac{DE}{DF} = \frac{EP}{FG} \text{ or } \frac{1 + \cos a}{2} = \frac{\cos(B - C) - \cos A}{\cos(B - C) - \cos(B + C)}$$

This expression expanded is identical with (3a) except that the sign of $\cos A$ is negative, which means that in reading A its supplement is to be taken; in other words the A scale is inverted, as indicated on the ordinate scale through the center of fig. 2. Except for this change in sign the two charts are identical and the single cosine chart can be used for the solution of the two equations (2a) and (3a); but in the first case the ordinate is $\cos a$, and in the second the ordinate is $\cos A$. This is an undesirable feature which can be readily eliminated by rotating the x, y axes of the chart for (3a) through 90°;

this means an interchange of the x, y axes and is done by suitable designation of the angles on the chart. This change is important and greatly extends the usefulness of the chart because the intersection of the two straight lines, represented by equations (2a) and (3a), determines both a and A simultaneously. The exact labeling of the several cosine scales is shown in fig. 3 and on plate 1, and once accomplished needs no further attention.

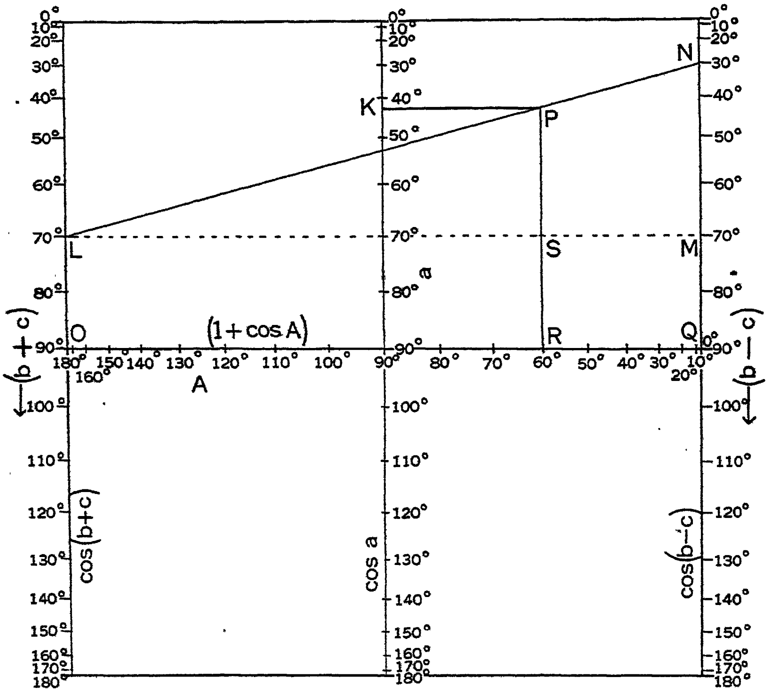


Fig. 1. Straight line cosine diagram for the graphical solution of a spherical triangle in which two sides b, c and an included angle A or the third side a are given; to find the third side a or the included angle A. Pass a straight line through the points L [angle $(b+c)$; distance $LO = \cos(b+c)$] and N [angle $(b-c)$; distance $NQ = \cos(b-c)$]; intersection P of this line with the ordinate erected at R [angle A; distance $OR = 1 + \cos A$; or angle a; distance $PR = \cos a$] is the desired point P which determines A and a.

The use of the chart is best illustrated by a series of examples which cover all possible cases that may arise. To solve these examples, however, the sine formula (1) is required and for its solution the cosine chart suffices, provided the sine scales are properly indicated thereon. If, in the sine formula $\sin a = y_1$, $\sin b = y$, $\sin A = x_1$, and $\sin B = x$, we have $y = \frac{y_1}{x_1} \cdot x$, which is the equation of a straight line passing through the origin. If therefore on plate 1, the ori-

gin be considered to be shifted from O to the center of the chart and the sines of the angles are plotted in both the x and y directions (fig. 4), the lines of plate 1 suffice, providing the numbers in parentheses are used for the angles, as indicated in figure 4 and also on plate 1 (*NE* quadrant). When the scale numbers in parentheses are used the chart is a sine chart and is so designated in the examples; otherwise it is called the cosine chart.

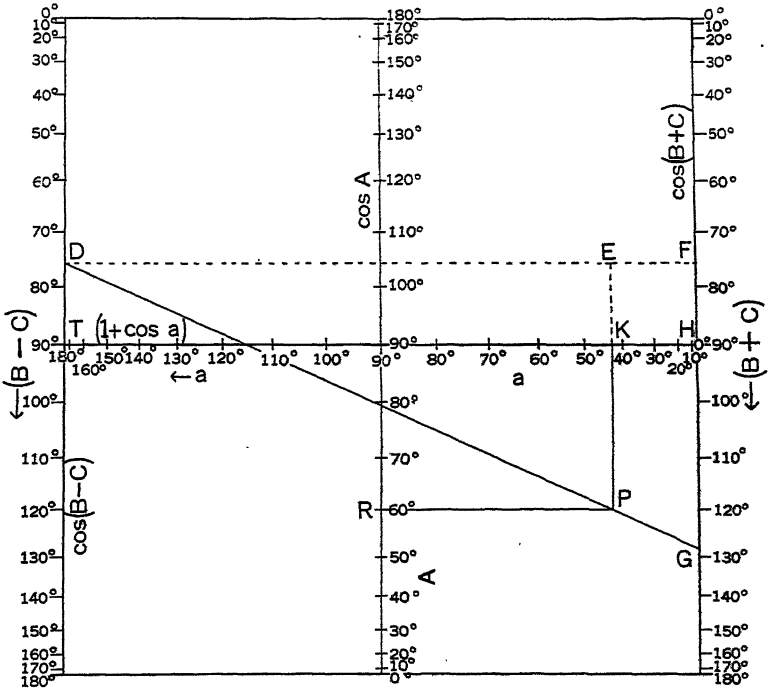


Fig. 2. Straight line cosine diagram for the solution of a spherical triangle in which two angles B, C and one included side a or the third angle A are given; sought either the third angle A, or the included side a. Construction similar to that of fig. 1. Intersection of line through points D [$TD = \cos(B-C)$] and G [$GH = \cos(B+C)$] with the ordinate KP erected at K ($TK = 1 + \cos a$, $KP = -\cos A$), determines the point P and with it A and a.

(1) Given the three sides of a spherical triangle: $a = 42°42'$ $b = 50°$, $c = 20°$. Find the three solid angles A, B, C.

On a piece of tracing paper held in position over the cosine chart (plate 1, also figs. 1 and 3) pass a straight line or simply a straight edge through $b + c = 70°$ (left side of chart) and $b - c = 30°$ (right side of chart) and read the abscissa $A = 60°$ for the point of intersection of the ordinate $a = 42°42'$ with the straight line.

Having found A, the observer reads off the remaining angles $B = 102°$, $C = 26°$, directly from the sine chart (plate 1 and fig. 4) from the relations:

$$\frac{\sin C}{\sin c} = \frac{\sin A}{\sin a} \text{ and } \frac{\sin B}{\sin b} = \frac{\sin A}{\sin a}$$

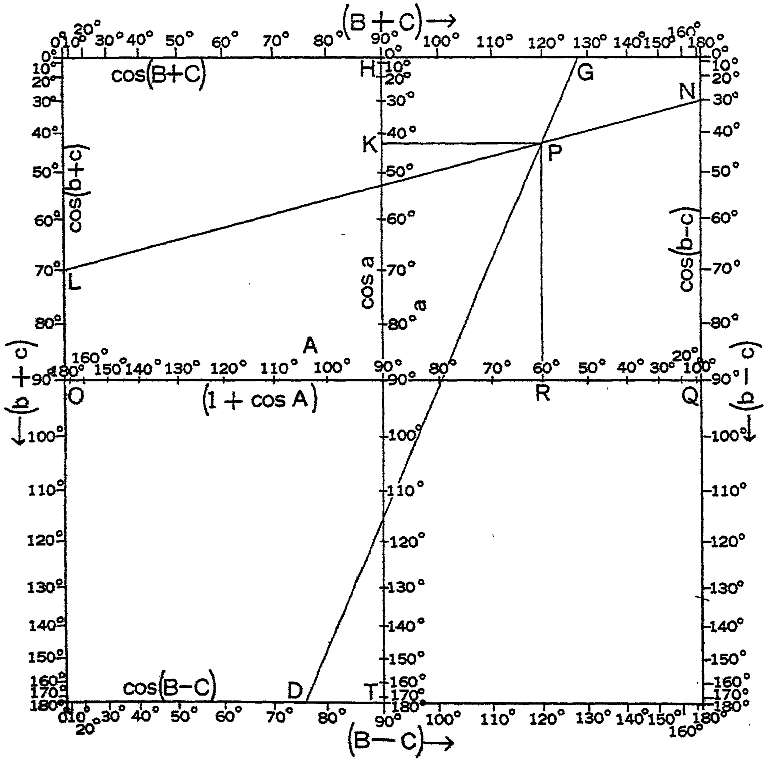


Fig. 3. Straight line cosine diagram for the solution of any spherical triangle in which any three of the six elements are given. In this chart the scales on the horizontal lines refer to the angles A, B, C; the scales on the vertical lines refer to the sides a, b, c. In case two sides and the included angle or the third side are given the construction described under fig. 1 is used; if two angles and the included side or the third angle are given, the construction of fig. 2 is followed except that in this diagram the axes of fig. 2 have been rotated through 90°, as indicated by the labeled scales. For the case that two sides and an opposite angle or two angles and an opposite side are given, it is necessary first to find the second opposite angle of the second side by the use of the sine chart (fig. 4) and to plot the lines LN and DG, the intersection P of which determines the remaining angle and side simultaneously.

It should be noted that when the sine chart is used ambiguity is apt to arise because sin $(180° - a) = \sin a$. In general this is not serious and the observer can tell on inspection whether the angle given on the sine chart or its supplement is to be taken. In any

spherical triangle $A + B + C > 180°$. In case of doubt the correctness of the angle selected can be tested on the chart by the method followed in examples 5 and 6 below.

(2) Given the three solid angles of a triangle: $A = 60°$, $B = 101°56'$, $C = 25°54'$. To find the three sides a, b, c.

The straight line through the points $(B + C) = 127°50'$ at the top of the cosine chart and $B - C = 76°02'$ at its base intersects the ordinate erected at the abscissa $A = 60°$ at the point $a = 42.7°$ (Plate 1 and figs. 1 and 3). The remaining angles $b = 50°$, $c = 20°$ can be read off directly from the sine chart after A has been found.

(3) Given two sides and the included angle: $b = 50°$, $c = 20°$, $A = 60°$. To find a, B, C.

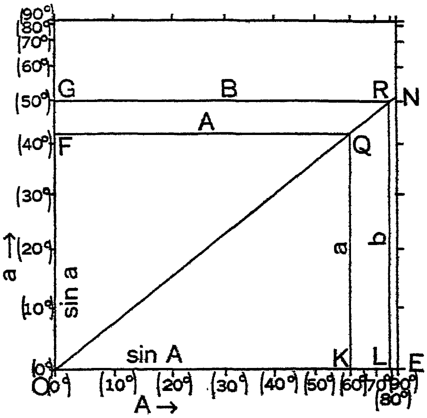


Fig. 4. Straight line sine diagram for the solution of the sine formula of spherical trigonometry. This chart, which has long been used, is the northeast quadrant of plate I and is based on the relation $\sin a : \sin b = \sin A : \sin B$. In fig. 4 $QK = \sin a$, $OK = \sin A$, $RL, = \sin b$, $OL = \sin B$. If any three of these four elements are known, the fourth can be read off directly from the diagram by virtue of the similar triangles OQK and ORL.

Find on the cosine chart the intersection of the straight line passing through the points $b + c = 70°$ and $b - c = 30°$ with the ordinate erected on the abscissa $A = 60°$. The point of intersection is at $a = 42.7°$. The angles $B = 102°$ and $C = 26°$ can now be read off directly from the sine chart. Note that $B = 102°$ and not $B = 78°$ because $A + B + C > 180°$.

(4) Given two solid angles and the included side: $B = 101°56'$, $C = 25°54'$, $a = 42°42'$. To find A, b, c.

Pass a straight edge through the points $B + C = 127°50'$ at top of chart and $B - C = 76°02'$ at bottom of chart and note that it intersects the ordinate $a = 42°42'$ at the abscissa distance $A = 60°$. Read now angles $b = 50°$, $c = 20°$ directly from the sine chart.

(5) Given two sides and an adjacent solid angle: $b = 50°$, $c = 20°$, $B = 101°56'$. To find A, C, a.

From sine chart read angle $C = 26°$. Draw on tracing paper over cosine chart the two straight lines passing through the points $b + c = 70°$ and $b - c = 30°$; and $B + C = 127°56'$, and $B - C = 75°56'$, respectively. Coordinates of the point of intersection of these two lines are the desired angles $A = 60°$ and $a = 42.7°$. In case there is doubt about the value of C, whether 26° or its supplement, 154°, is to be taken, solve for both values and find that for the second set a solution is not possible because the lines do not intersect.

(6) Given two angles and an adjacent side: $B = 101°56'$, $C = 25°54'$, $b = 50°$. To find c, a, A.

From the sine chart read off directly $c = 20°$. Find on the cosine chart the coördinates $A = 60°$, $a = 42.7°$ of the point of intersection of the straight line passing through the points $b + c = 70°$ and $b - c = 30°$ with the straight line through the points $B + C = 127°50'$ and $B - C = 76°02'$.

These examples suffice to prove that the straight line cosine chart together with the sine chart, which it includes, is competent to solve any spherical triangle and with a satisfactory degree of accuracy for many purposes. Still greater precision can be obtained by substituting accurately divided metal scales and slides for the scales at the sides and top and bottom; also for the two central scales; but this is then a trigonometric computer and no longer a graphical method.

In case the degree of precision of plate 1 is not adequate a somewhat higher degree of exactness can be obtained by the use of Chart No. 2776 of the U. S. Hydrographic Office, but relabeled to correspond with plate 1.

SUMMARY

The straight line cosine chart first proposed by M. d'Ocagne for the solution of the triangle for the spherical distance between two points, whose latitudes and longitudes are known, has recently been applied by Littlehales to the solution of the spherical triangle required by the Sumner line method of navigation. Satisfactory as the chart is for this particular problem, its range of usefulness can be extended so as to include the solution of any spherical triangle for which any three angles are known. To attain this result it is necessary to relabel the scales of the d'Ocagne chart and to assign to each of the six identical scales definite angles of the spherical triangle.

A straight line is passed through points on the scales at the sides or the top and bottom of the chart. The unknown angles are then determined by the intersection of this straight line either with a given ordinate or with a second straight line. The accuracy attainable by a chart of this kind is commonly one to two tenths of a degree of arc, depending somewhat on the angles of the spherical triangle; it may mount to a degree or more in an unfavorable case.

The possibility is also suggested of constructing a simple trigonometric computer based on this principle.

SPECTROSCOPY.—*Regularities in the arc spectrum of cobalt.* FRANCIS M. WALTERS, JR., Bureau of Metallurgical Research, The Carnegie Institute of Technology. (Communicated by W. F. MEGGERS.)

Last year a note was published[1] announcing the discovery of regularities in the arc spectrum of iron. These were the first regularities in the spectrum of any element placed in the eighth column of the periodic table. The alternation law was thus verified for the first member of one of the triads in this column since the iron-arc spectrum was found to contain terms of odd maximum multiplicities. Cobalt follows iron in the table and if the alternation law continues to hold, its arc spectrum would be expected to consist of combinations of terms whose maximum multiplicities are even. Such has been found to be the case.

This preliminary note gives twelve multiplets in the quartet system of the arc spectrum of cobalt. These multiplets result from the combination of two P-levels, two D-levels, three F-levels and one G-level, and involve 88 of the 315 lines of cobalt of temperature classes I and II.

Table 1 containing the multiplets shows the types of combining terms, the wave-lengths[2] of the lines involved, the vacuum wave-numbers, the temperature classification,[3] and the intensity, and character in the arc as given by King.[3]

That the levels F and F′ are the lowest of the levels concerned in these multiplets is shown by combinations of the remaining levels with others (not given in this paper) which involve lines of tempera-

[1] This JOURNAL 13: 243. 1923. Extended results appear in J. O. S. A. & R. S. I. 8: 245. 1924.

[2] Dhein, Zeitschr. wiss. Phot. 19: 289–335. 1920.

[3] Astrophys. Journ. 42: 344–364. Ibid. 51: 179–186. 1920.

TABLE 1.—MULTIPLETS IN THE ARC SPECTRUM OF COBALT (QUARTET SYSTEM)

Multiplet 1.

	F_5		F_4		F_3		F_2
	80R–II		30r–I		15–I		
	3412.636		3510.419		3584.796		
D_4	29294.50	*815.98*	28478.52	*590.85*	27877.67		
			654.28		*654.15*		
			50r–II		20r–I		8–I
			3431.579		3502.63		3552.710
D_3			29132.80	*590.98*	28541.82	*402.37*	28139.45
					494.97		*494.82*
					20r–II		15–I
					3442.924		3491.324
D_2					29036.79	*402.52*	28634.27
							299.05
							25r–I
							3455.236
D_1							28933.32

Multiplet 2.

	F_5		F_4		F_3		F_2
	10–II		4–I		5–I		
	3121.414		3203.030		3264.842		
D'_4	32027.51	*815.86*	31211.45	*590.88*	30620.57		
			627.07		*627.02*		
			12–II		4–I		
			3139.943		3199.325		
D'_3			31838.52	*590.93*	31247.59	— —	30845.12
					406.30		
					10–II		5–I
					31493.04		3189.756
D'_2					31743.89	*402.55*	31341.34
							298.44
							10–II
							3159.660
D'_1							31639.78

Multiplet 3.

	F_5		F_4		F_3		F_2
	100R–II		20r–I				
	3526.856		3631.390				
F''_5	28345.79	*815.93*	27529.86				
	431.10		*431.40*				
	100R–II		60r–II		15–I		
	3474.019		3575.361		3652.544		
F''_4	28776.89	*815.63*	27961.26	*590.85*	27370.41		
			439.04		*439.12*		
			15–II		50R–II		12–I
			3520.087		3594.869		3647.663
F''_3			28400.30	*590.77*	27809.53	*402.49*	27407.04
					346.71		*346.81*
					20r–I		40R–II
					3550.599		3602.081
F''_2					28156.24	*402.39*	27753.85

Multiplet 4.

	F_5	F_4	F_3	F_2
G_6	100R–II 3465.796 28845.17			
	424.53			
G_5	6–I 3415.527 29269.70—*816.02*—	50R–II 3513.483 28453.68		
		465.42		
G_4	29735.03	9–I 3456.936 28919.10—*590.83*—	30r–I 3529.037 28328.27	
G_3		29286.95	28696.12	25r–I 3533.363 28293.60

Multiplet 5.

	F'_5	F'_4	F'_3	F'_2
D_4	60–II 3873.117 25811.70—*659.86*—	10–I 3974.632 25151.84—	—24604.47	
		654.26		
D_3		40–II 3873.907 25806.10—*547.54*—	15–II 3957.935 25258.56—*385.61*—	5–I 4019.300* 24872.95
			494.70	*494.84*
D_2			25–I 3881.911 25753.26—*385.47*—	12–I 3940.895 25367.79
				299.03
D_1				60–II 3894.981 25666.82

Multiplet 6.

	F'_5	F'_4	F'_3	F'_2
D'_4	100R–II 3502.281 28544.69—*659.84*—	25R–I 3585.159 27884.85—*547.53*—	7–I 3656.965 27337.32	
		627.00	*627.05*	
D'_3		80R–II 3506.315 28511.85—*547.48*—	25r–I 3574.964 27964.37—*385.64*—	8–I 3624.955 27578.73
			496.11	*496.11*
D'_2			60R–II 3512.643 28460.48—*385.64*—	20r–I 3560.896 28074.84
				298.45
D'_1				25r–I 3523.438 28373.29

* This line is also used in multiplet 7.

Multiplet 7.

	F'_5		F'_4		F'_3		F'_2
F''_5	20–I 4020.904 24863.02	—*659.90*—	1u 4130.538 24203.12				
	431.39		*431.49*				
F''_4	8–I 3952.329 25294.41	—*659.80*—	8–I 4058.188 24634.61	—*547.56*—	3u–IIA 4150.442 24087.05		
			439.08		*439.10*		
F''_3			6–I 3987.121 25073.69	—*547.54*—	4–IA 4076.134 24526.15		—24140.50
					346.80		
F''_2					5–I 4019.300 24872.95	—*385.67*—	3–IA 4082.606 24487.28

Multiplet 8.

	F'_5		F'_4		F'_3		F'_2
G_6	20–II 3941.735 25362.39						
	424.53						
G_5	20–I 3876.840 25786.92	—*659.88*—	10–I 3978.656 25127.04				
	465.43		*465.44*				
G_4	10–I 3808.106 26252.35	—*659.87*—	10–I 3906.296 25592.48	—*547.50*	6–I 3991.693 25044.98		
			367.81		*367.78*		
G_3			4–IA 3850.29 25960.29	—*547.53*—	6–I 3933.921 25412.76	—*385.64*—	6–I 3994.541 25027.12

Multiplet 9.

	P_3		P_2		P_1
D_4	80–I 6450.231 15499.05				
	654.24				
D_3	10–IIA 6188.980 16153.29	—*240.81*—	40–I 6282.640 15912.48		
	494.88		*494.90*		
D_2	3 6005.008 16648.17	—*240.79*—	10–I 6093.138 16407.38	—*363.15*—	5–III 6231.050 16044.23
			298.72		*299.19*
D_1			3 5984.182 16706.10	—*362.68*—	8–I 6116.982 16343.42

Multiplet 10.

	P'$_3$		P'$_2$		P'$_1$
	15–I				
	7084.970				
D$_4$	14110.50				
	654.18				
	20–I		8–I		
	6771.05		7052.854		
D$_3$	14764.68	*589.92*	14174.76		
	494.90		*494.82*		
	3–III		15–I		3–I
	6551.45		6814.954		7016.596
D$_2$	15259.58	*590.00*	14669.58	*421.57*	14248.01
			299.01		*298.99*
			4–II		10–I
			6678.812		6872.38
D$_1$			14968.59	*421.59*	14547.00

Multiplet 11.

	P$_3$		P$_2$		P$_1$
	40–I				
	5483.336				
D'$_4$	18232.02				
	626.99				
	15–II		20–I		
	5301.036		5369.580		
D'$_3$	18859.01	*240.74*	18618.27		
	496.14		*496.13*		
	3–IV?		25–II		15–II
	5165.148		5230.204		5331.450
D'$_2$	19355.15	*240.75*	19114.40	*362.98*	18751.42
			298.44		*298.50*
			4–II		15–II
			5149.800		5237.912
D'$_1$			19412.84	*362.92*	19049.92

Multiplet 12.

	P'$_3$	P'$_2$	P'$_1$
	5–III		
	5935.372		
D'$_4$	16843.48		
		1u	
		5922.350	
D'$_3$	17470.47	16880.53	
D'$_2$	17966.69	17376.73	16955.12
D'$_1$		17675.10	17253.49

ture classes III, IV, and V. It is noteworthy that six of the eight multiple levels occur in pairs separated by rather small wave-number intervals: $P' - P = 1300$; $D' - D = 2700$; $F' - F = 3800$.

In the region covered by the measurements of Dhein, de Gramont has indicated seven lines as *raies ultimes*, of which one, 3474.019A, appears in the multiplets given here. The "persistent" lines observed by Pollok and Leonard,[4] 3412.636, 3465.796, 3474.019, 5302.281 and 3873.117A are found one to a multiplet.

Seven of the lines for which Rybar[5] gives the Zeeman effects are found in these multiplets. A comparison of the patterns observed by Rybar and those calculated by Landé's scheme[6] is given in Table 2.

TABLE 2.—ZEEMAN EFFECT FOR COBALT LINES

λ	TERMS	CALCULATED	OBSERVED
3455.236	D_1F_2	(0.20) 0.20,**0.60**	(0.20) 0.59
3523.438	D_1F_2	(0.20) 0.20,**0.60**	(0.20) 0.59
3894.981	D_1F_2	(0.20) 0.20,**0.60**	(0.20) 0.60
3491.324	D_2F_2	(0.40, **1.20**) 0.00, **0.80**, 1.60	(1.18) **0.02**, 0.80, 1.59
3560.898	D_2F_2	(0.40, **1.20**) 0.00, **0.80**, 1.60	(1.21) **0.00**, 0.80, 1.59
3940.895	D_2F_2	(0.40, **1.20**) 0.00, **0.80**, 1.60	(1.17) **0.00**, 0.79, 1.58
3585.159	D_4F_4	(0.10, 0.27, 0.48, **0.67**) 0.76, 0.95, 1.14, **1.33**, 1.52, 1.71, 1.90	(0 51) 1.36

It is of interest to compare the structures of the arc spectrum of cobalt with those of the preceding element, iron. Whereas the terms found in the arc spectrum of iron belong to systems of odd permanent multiplicity (triplets, quintets, septets), those found for cobalt belong to even systems. In addition to the quartet system represented by the above multiplets there is good evidence of doublet terms, and terms belonging to the sextet system are expected in the final analysis.

In the arc spectrum of iron all of the terms are "inverted," that is, in a given multiple level the magnitude of the term increases with the inner quantum number, whereas the terms in cobalt are normal, resembling those of the majority of elements with complex spectra. This abrupt change from iron is of interest, since in approaching iron along a row of the periodic table from the other direction we find titanium and vanadium with all terms normal, chromium with a few inverted terms, manganese with many and iron with all terms inverted.

The separations of the sub-levels of the quartet system of cobalt average 3 to 4 times larger than corresponding separations for the sub-levels of the quintet-system terms in iron.

[4] Roy. Dublin Soc. Proc. **11**: no. 18. 1907.
[5] Physik. Zeitschr. **12**: 889. 1911.
[6] Zeitschr. für Physik. **15**: 190. 1923.

BOTANY.—*New plants from the Dominican Republic.*[1] E. C. LEONARD, National Museum (Communicated by WILLIAM R. MAXON).

The new species described in this paper are based upon material collected by Dr. W. L. Abbott in the early part of 1922. Prior to 1920 only a small proportion of the plants known to occur in the Dominican Republic were represented in the National Herbarium by specimens from that country, these consisting mainly of collections by Wright, Parry, and Brummel in 1871, Rose in 1913, and certain numbers of Türckheim, Fuertes, and Raunkiaer received from Berlin and Copenhagen. During the past four years, however, Dr. Abbott has collected nearly 3,000 numbers. Of these many have proved new to science and a considerable number are new to the National Herbarium.

Botanically, Hispaniola is probably the least known of the West Indies, and both Haiti and the Dominican Republic offer an extremely rich field to the collector.

Sophora albo-petiolulata Leonard, sp. nov.

Plant shrubby; stipules none; leaves 5 to 10 cm. long, the rachis white-pubescent, deeply grooved on upper side; leaflets 12 to 16, elliptic, 8 to 10 mm. long, 2 to 5 mm. wide, rounded at both ends, entire, recurved on margins, obscurely punctate, the upper surface bright green, the lower surface paler; petiolules yellowish white, about 1.5 mm. long, pubescent; racemes terminal, 8 to 10 cm. long, velvety-pubescent; flowers 14 to 20, white, the standard broadly ovate, abruptly narrowed to a claw, 15 mm. long, 13 mm. broad, emarginate, the other petals 12 to 13 mm. long, 4 to 5 mm. broad; stamens 10, 9 to 10 mm. long; calyx 5 mm. long, silky-pubescent; pedicels 6 to 7 mm. long, silky-pubescent; ovary densely white-pubescent; pods not seen.

Type in the U. S. National Herbarium, no. 1,079,459, collected at Maniel Viejo, Province of Barahona, Dominican Republic, altitude 750 meters, March 10, 1922, by W. L. Abbott (no. 1934). Abbott's no. 1911 collected at the same locality is of this species.

No West Indian *Sophora* closely related to this species has hitherto been described. In shape and size of the leaflets it bears some resemblance to *S. macrocarpa* from Chile, but differs in its much smaller flowers.

Zanthoxylum bifoliolatum Leonard, sp. nov.

Tree, glabrous throughout, the branches sparingly armed with straight spines 2 to 4 mm. long; petioles 2 cm. long, grooved on upper surface, bearing a pair of spines at base of leaflets; leaflets 2, opposite, obovate, 4 to 8 cm. long, 2 to 4.5 cm. wide, rounded and emarginate at apex, gradually narrowed to a subsessile, often oblique base, coriaceous, entire, the upper sur-

[1] Published by permission of the Secretary of the Smithsonian Institution.

face shining, prominently veined, the lower surface duller, minutely glandular, the veins prominent, the midrib usually bearing a spine below the middle; flowers 2 to 3 in the axils of the leaves; staminate flowers on pedicels 2 to 2.5 mm. long; calyx 3-lobed, minute; petals 3, ovate, 2 mm. long, 1.5 mm. broad; stamens 3, 4 to 5 mm. long; fruit not seen.

Type in the U. S. National Herbarium, no. 1,079,511, collected on Quita Espuela, in the vicinity of San Francisco de Macorís, Provincia Pacificador, Dominican Republic, altitude 1,000 meters, April 7, 1922, by W. L. Abbott (no. 2083).

Zanthoxylum bifoliolatum differs from other tropical American plants of this genus in having only two leaflets and in its small axillary inflorescence.

Zanthoxylum venosum Leonard, sp. nov.

Tree (?) or shrub, glabrous throughout, armed with straight conical spines 2 mm. long; leaves odd-pinnate, 6 to 12 cm. long; petioles seldom armed, not grooved; rachis sparingly armed with short spines, shallowly grooved above; leaflets usually 5, opposite, elliptic to obovate, 3 to 7 cm. long, 1.5 to 3 cm. wide, narrowed to an obtuse point at apex, narrowed at base to a grooved petiolule 3 to 6 mm. long, prominently nerved and veined, very firm, coriaceous, entire, glabrous, both surfaces pellucid-glandular, shining, dark green above, paler beneath, the midrib on the under surface often bearing a small spine near the middle; inflorescence terminal, corymbose, glandular, armed with slender spines 2 to 2.5 mm. long, the flowers numerous; staminate flowers on pedicels 1.5 to 2 mm. long; sepals 3, 1 mm. long, ovate, rounded at apex; petals 3, ovate, 2.5 mm. long, 1.5 mm. wide; stamens 3, equaling the petals; pistillate flowers and fruit not seen.

Type in the U. S. National Herbarium, no. 1,079,475, collected on the summit of Loma de Cielo, near Polo, Province of Barahona, Dominican Republic, altitude 1,300 meters, March 12, 1922, by W. L. Abbott (no. 1969).

Although apparently related to *Zanthoxylum coriaceum* A. Rich., this plant differs strongly from that species in its more pointed, conspicuously veined, pellucid-glandular leaves and armed stems.

Maba urbaniana Leonard, sp. nov.

Shrub or tree (?); bark gray, the tips of the young branches densely brown-pubescent; petioles 2 to 3 mm. long, densely pubescent; leaves obovate to oval, 1.5 to 3 cm. long, 0.5 to 2.5 cm. wide, rounded and occasionally emarginate at apex, narrowed from above the middle to a truncate or subcordate or rarely rounded base, entire, strongly reticulate, the upper surface shining, glabrous or slightly pubescent, drying tawny-olive, the veins impressed, the lower surface densely and softly pubescent, drying buckthorn-brown, flowers 2 to 3 in short axillary clusters; pedicels 2 to 3 mm. long, densely and softly tawney-brown pubescent; calyx 3 mm. long, 3-lobed, the lobes broadly triangular, pubescent without, glabrous within; corolla about 8 mm. long, pubescent, 3-lobed, the lobes 1 mm. long, thick, leathery; stamens 10, the longer 3 mm., the shorter 1.5 mm.; fruit not seen.

Type in the U. S. National Herbarium, no. 1,179,585, collected in the vicinity of San Lorenzo Bay, Dominican Republic, near sea level, April 26, 1922, by W. L. Abbott (no. 2235).

This species is distinct from its nearest relative, *M. caribaea* (A.DC.) Hieron, in the smaller and more crowded leaves and the denser soft brown pubescence of the under surface of the leaf blades.

Solanum abbottii Leonard, sp. nov.

Shrub, 1 to 1.5 meters high; young twigs rather densely stellate-pubescent with 5 to 7-rayed hairs and armed with straight yellow spines about 5 mm. long; petioles 10 to 15 mm. long, stellate-pubescent and spinose; leaves oblong-elliptic in outline, 10 to 15 cm. long, 3 to 6 cm. wide, acutish at apex, narrowed from near the middle to base, sinuately 5 to 7-lobed, the lobes obtuse, the sinuses shallowly rounded, the upper surface dull green with occasional spines and stellate hairs on the impressed veins, otherwise glabrous, the lower surface yellowish green, rather densely pubescent with easily detached stellate hairs and with occasional spines; racemes axillary, up to 8 cm. long, 8 to 14-flowered; pedicels 6 to 10 mm. long, glabrous; calyx stellate-pubescent and spiny, the lobes triangular, abruptly long-acuminate; corolla violet, the lobes lance-ovate, 10 to 12 mm. long, 4 mm. broad, acutish, glabrous within, stellate-pubescent without; stamens and style equal and nearly erect, the anthers 4 to 5 mm. long; fruit not seen.

Type in the U. S. National Herbarium, no. 1,079,509, collected on the summit of Quita Espuela in the vicinity of San Francisco de Macorís, Provincia Pacificador, Dominican Republic, altitude 900 meters, April 7, 1922, by W. L. Abbott (no. 2073). An additional specimen was collected in the same region, April 10, 1922, by W. L. Abbott (no. 2124).

According to description, *Solanum orthacanthum* O. E. Schulz[2] agrees with the proposed new species in many respects, especially in general leaf-shape and in the character of the pubescence, but differs in having larger leaves (15 to 20 cm. long) with oblique cordate base and faintly repand margin, fewer flowers (about 4 in each raceme), shorter tomentose pedicels (2 to 4 mm. long), and larger corolla lobes (lobes 15 mm. long).

Tabebuia rugosa Leonard, sp. nov.

Small tree; young branches thick, gray; leaves 3-foliolate; petioles very stout, 1 cm. long; petiolules 1 cm. long or less; leaflets ovate to elliptic, 12 to 17 cm. long, 6 to 11 cm. wide, rounded and usually minutely apiculate at apex, obliquely subcordate at base, coriaceous, the margins entire or undulate, recurved, the upper surface glabrous, lepidote (?), strongly rugose and shining, the veins impressed, the lower surface drying light grayish brown, prominently and reticulately veined, the midrib and primary and secondary veins glabrous, the anastomosing veins densely and softly pubescent, otherwise glabrous; inflorescence terminal, umbellate, brown-lepidote; pedicels 4 to 5 mm. long; calyx 12 to 13 mm. long, lepidote, the lobes triangular, acute; corolla 3 to 3.5 cm. long, "red," the stamens inserted on the corolla tube 5 mm. above the base, the longer stamens 15 mm. long, the shorter 12 mm., the anthers 3.5 mm. long.

Type in the U. S. National Herbarium, no. 1,079,609, collected near Lajana on the Samaná Peninsula, Dominican Republic, altitude 100 meters, April 30, 1922, by W. L. Abbott (no. 2272).

This species may be related to *T. acrophylla* (Urban) Britton, as a similarity in texture and shape of leaves seems to indicate, but in other respects

[2] Urban. Symb. Antill. **7**: 537. 1903.

the two plants are different. The flowers of *T. acrophylla* are twice as large and the leaflets are smaller and obovate and pubescent on both surfaces, including the primary and secondary veins of the lower surface.

Dr. Abbott's no. 2293, collected in the same region, May 2, 1922, and possibly from the same tree, consists of leaves and mature pods. The pods are up to 18 cm. long, 5 mm. thick, rough-lepidote, with slender awn-like tips; the seeds are 7 mm. long, 5 mm. wide, the wings 5 to 7 mm. long.

Tabebuia rubriflora Leonard, sp. nov.

Large tree; twigs thick, gray; leaves 4 or 5-foliolate, the petioles up to 8 cm. long; petiolules 0.5 to 2 cm. long; leaflets elliptic to obovate-oblong, 5 to 12 cm. long, 2.5 to 6 cm. wide, obtusish at apex, rounded or subcordate at base, coriaceous, entire, slightly lepidote on both surfaces, pubescent in the angles of the veins on the lower surface, otherwise glabrous; flowers in axillary, 2 to 4-flowered, subsessile clusters; pedicels 8 to 10 mm. long; calyx 6 to 7 mm. long, sparsely lepidote, the lobes triangular, 2 to 3 mm. long, acute; corolla 2.5 to 3 cm. long, deep red, the tube 2.5 mm. wide at base, 15 mm. wide at throat; capsules smooth, up to 12 cm. long; seeds 10 mm. long, 4 to 5 mm. wide, the wings 4 to 5 mm. long.

Type in the U. S. National Herbarium, no. 1,079,657, collected in the vicinity of Laguna, on the Pilón de Azúcar, Dominican Republic, altitude 500 meters, May 12, 1922, by W. L. Abbott (no. 2346).

In texture and size of leaflets this species resembles *T. pachyphylla* Britton, from Cuba, but differs in its much smaller flowers and broader leaflets.

Tabebuia paniculata Leonard, sp. nov.

Shrub or small tree; petioles 1 to 2 cm. long; leaves 3 to 5-foliolate, the petiolule of the middle leaflet 5 to 10 mm. long, the lateral leaflets subsessile; leaflets elliptic to obovate, 3 to 8 cm. long, 1.5 to 4 cm. wide, rounded and emarginate at apex, gradually narrowed at base (the lateral leaflets oblique), thick, coriaceous, entire, the upper surface with impressed nerves, glabrous or slightly lepidote, drying dark brown, the lower surface with prominent nerves, lepidote, drying light brown; inflorescence terminal, paniculate, lepidote, the bracts subulate 1.5 to 8 mm. long, the flowers numerous; pedicels 1 to 2 cm. long, lepidote; calyx 2-lipped, 10 to 12 mm. long, lepidote; corolla 4 cm. long, purplish (?), veiny, the tube 3 mm. wide at base, enlarging to 15 mm. at throat; pods not seen.

Type in the U. S. National Herbarium, no. 1,079,633, collected in the vicinity of Laguna, on the Pilón de Azúcar, Dominican Republic, altitude 500 meters, May 11, 1922, by W. L. Abbott (no. 2330).

Tabebuia paniculata is related to *T. pentaphylla* Hemsl., and differs chiefly in its short petioles and more rounded leaflets. It resembles *T. gonavensis* Urban in some respects, but has much larger leaflets and smaller flowers.

Justicia alsinoides Leonard, sp. nov.

Diffuse herb; stems weak, branched, usually decumbent, rooting at the nodes, 10 to 15 cm. long, terete, obscurely grooved, pubescent with downwardly curved hairs, bearing white linear straight cystoliths 0.25 mm. long; petioles 5 to 8 mm. long, the under surface pubescent with curved hairs,

the upper bearing cystoliths; leaves ovate, 10 to 18 mm. long, 8 to 10 mm. wide (the upper and lowermost usually smaller), obtuse at apex, rounded, subcordate, or abruptly narrowed at base, shortly decurrent on petiole, the upper surface bearing numerous cystoliths, glabrous or with a few scattered hairs, the lower surface glabrous, bearing a few cystoliths; inflorescence spicate, 2 to 4 cm. long, 4 to 6-flowered; bracts linear, lanceolate, 2.5 mm. long; calyx lobes linear-lanceolate, 4 mm. long, sparsely pubescent, 3-nerved, the lateral nerves less prominent than the median; corolla 5 mm. long, pinkish, the tube glabrous, the lips equal, 2 mm. long, puberulent without, the upper ovate, notched, the three lobes of the lower lip equal in size, rounded; style 3.5 mm. long (?); capsule 6 mm. long, puberulent, 4-seeded, the retinacula 1 mm. long; seeds flat, stipitate at base, orbicular, 1 mm. in diameter, reddish brown, minutely reticulate.

Type in the U. S. National Herbarium, no. 1,979,513, collected on the summit of Quita Espuela, in the vicinity of San Francisco de Macorís, Provincia Pacificador, Dominican Republic, altitude 900 meters, April 8, 1922, by W. L. Abbott (no 2119a).

This plant is closely related to *J. reptans*, and may be only a form of that species. It differs chiefly in the size of the sepals, which are at least twice as long as those of *J. reptans*. Likewise, both corolla and capsule are noticeably larger and the leaves are more rounded at the base.

Siphocampylos linearifolius Leonard, sp. nov.

Herbaceous; stems 36 cm. high (or higher?), glabrous; leaves narrowly ovate-oblong, 4 to 7 cm. long, 4 to 11 mm. wide, tapering from below the middle to an obtuse apex, narrowed to a short winged petiole 1 to 2 mm. long, serrate with small sharp teeth or the upper nearly entire, glabrous on both surfaces; flowers in the axils of the upper leaves; pedicels 2 cm. long, puberulent, bearing two subulate bracts near the middle; calyx lobes narrowly triangular, 6 to 7 mm. long, 1 mm. wide at base, puberulent, often reddish; corolla 2.5 to 3 cm. long, red, the lips equal, the lobes of the lower lip narrowly triangular, 5 mm. long, 2 mm. broad at the base, obtuse at apex, yellow in dried plants, the lobes of the upper lip ovate, 7 to 8 mm. long, 3 mm. broad at base, obtuse at apex; styles 2 cm. long; anthers 3.5 to 4 mm. long, densely barbellate at apex; capsule 6 mm. long; seeds 0.5 mm. in diameter, grayish brown, reticulate.

Type in the U. S. National Herbarium, no 1,079,436, collected at Maniel Viejo, Province of Barahona, Dominican Republic, altitude 1060 meters, March 8, 1922, by W. L. Abbott (no. 1903). Dr. Abbott's no. 1851, collected in the same region from the upper slopes of Loma de Cielo, near Polo, altitude 1,200 meters, March 2, 1922, is of this species.

Related to *S. tuerckheimii* Urban in the similarity of the flowers, the glabrous stems, and thin glabrous leaves, this plant is sufficiently distinct in its very narrow leaves and more distant teeth to deserve specific rank.

SCIENTIFIC NOTES AND NEWS

W. Taylor Thom, Jr., has been appointed geologist in charge of the newly formed section of Geology of Fuels in the Division of Geology, U. S. Geological Survey.

E. M. Spieker, geologist, has been granted leave of absence from the U. S. Geological Survey to give a course of instruction in geology at Ohio State University.

Maxwell N. Short was appointed junior scientist in the U. S. Geological Survey and has been assigned to work in Section of Petrology.

Dr. Joseph F. Rock sailed from San Francisco on September 30 for China, as head of an expedition that is to conduct botanical exploration in the interior of that country for the Arnold Arboretum. Dr. Rock returned early in the summer from a similar expedition, in the interest of the National Geographic Society and the Department of Agriculture, to Burma, Yunnan, and the borderland of Tibet where he collected approximately 70,000 specimens of plants. Work on this large collection is now in progress at the National Museum.

Miss Clara Southmayd Ludlow, entomologist at the Army Medical Museum, died September 29. Her work was mainly in connection with the disease prevention activities of the army.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 14 November 4, 1924 No. 18

SPECTROSCOPY.—*Spectrum regularities for scandium and yttrium.*[1] W. F. Meggers, Bureau of Standards.

Scandium and yttrium, with atomic numbers 21 and 39 respectively, occupy positions in the third column of the periodic table of the chemical elements following calcium and strontium in the second column which in turn follow potassium and rubidium in the first column. Whereas the arc spectra and some of the spark spectra characterizing the elements in the first two columns of the table have received fairly complete and satisfactory interpretations, the results for scandium and yttrium are still incomplete and uncertain. The writer has given some attention to the arc and spark spectra of these two elements, and although the final classifications will be postponed until supplementary investigations on Zeeman effect are completed, the main features of these spectra are sufficiently well established to be presented at this time.

Tables 1, 2, 3, and 4 contain, respectively, examples of multiplets in the arc and spark spectra of scandium, and the arc and spark spectra of yttrium. In these tables the types of combining spectral terms or energy levels, together with the separations of the sub-levels, are indicated at the margin of the multiplets. The individual spectral lines are represented by their observed wave lengths, and the corresponding wave numbers (waves per cm. in vacuo). Estimated relative intensities of the lines, and for scandium King's[2] temperature classes, appear above the wave lengths. The subscripts to the term symbols represent inner quantum numbers. Different spectral systems are conveniently distinguished by attaching to the term symbol a superscript

[1] Published by permission of the Director of the Bureau of Standards of the Department of Commerce.

[2] King, Astrophys. Journ. **54**: 28. 1921.

corresponding to the maximum or permanent multiplicity attainable, but since each of the succeeding tables refers to one system only, the superscripts have been omitted.

The results published by Moore[3] for the Zeeman effect of the yttrium and spark lines listed in tables 3 and 4 are reproduced in tables 5 and 6 where they are compared with the patterns calculated according to Landé.[4] The observed magnetic separations have been reduced to terms of the separation of a normal triplet as a unit. The parallel components, enclosed in parentheses, are followed by the perpendicular components. In some cases the calculated patterns are rather complex so that only the stronger components—those likely either to be resolved or to affect the measurements—are expressed in decimal form, the remaining weaker ones being indicated by asterisks. When two or more components are given the most intense one is distinguished by bold face type.

The Zeeman effect data in tables 5 and 6 are regarded as confirming most of the multiplets for arc and spark spectra of yttrium listed in tables 3 and 4. No Zeeman patterns have as yet been published for scandium lines, but special attention is directed to the close correspondence of spectral structures of scandium and yttrium which is evident from a comparison of tables 1 and 2 with tables 3 and 4, respectively. On account of this intimate resemblance it may be predicted that when the magnetic resolutions of scandium lines are observed the classified lines will be found to have the same patterns as those already found for the corresponding lines in the yttrium spectra.

1. *Arc spectrum of scandium* (ScI). Practically all of the strong arc lines of scandium can be arranged in combinations of doublet- or quartet-system terms. Most of these have already been published by Catalan[5] but his doublet term designations are probably in error. Professor H. N. Russell[6] suggested the correct arrangement of terms to me last year, and similar corrections supported by observations of the absorption spectrum have since been made by Gieseler and Grotrian.[7] The lowest level in the neutral atom is a doublet with separation of 168.35 wave numbers. This was regarded by Catalán as a P term but is more likely of the D type. The spectra of scandium are

[3] Moore, Astrophys. Journ. 28: 1. 1908.

[4] Landé, Zeit. f. Physik. 15: 189. 1923.

[5] Catalán, Anales Soc. Espan. Fis. y Quim. 20: 606. 1922. Ibid. 21: 464. 1923.

[6] Russell, In a letter addressed to the author, December 21, 1923. Astrophys. Journ. In Press. 1924.

[7] Gieseler and Grotrian, Zeit. f. Physik. 25: 342. 1924.

almost identical in structure with those of yttrium for which some Zeeman patterns have been published by Moore and the proof presented below that the normal state of the neutral atom of yttrium contains the last electron in a 3_3 orbit may, therefore, be considered to apply to scandium as well as to yttrium. Table 1 contains some examples of multiplets in the doublet system of ScI. The wave lengths and estimated intensities (scale 1 to 100) are from new determinations made at the Bureau of Standards.

TABLE 1.—DOUBLETS IN THE SPECTRUM OF ScI

	D_3	168.35	D_2
F_4	10, II 3019.33 33110.27		
124.63			
F_3	3, II 3030.74 32985.64		8, II 3015.35 33154.02
P_2	15, IIA 3273.64 30538.32		4, IA 3255.69 30706.66
133.57			
P_1			10, IIA 3269.91 30573.09
F_4	60, II 3911.81 25556.39		
140.07			
F_3	10, II 3933.37 25416.32		40, II 3907.49 25584.64
D_3	70, II 4023.69 24845.85		15, I 3996.61 25014.18
147.98			
D_2	10, I 4047.79 24697.89		50, II 4020.40 24866.17
$D_{2,3}$	30, I 4082.40 24488.52		20, I 4054.54 24656.80

TABLE 1.—DOUBLETS IN THE SPECTRUM OF ScI—*Continued*

	20,IA	
F_4	4779.35	
	20917.54	
53.08		
	5,IA	12,IA
F_3	4791.50	4753.16
	20864.46	21032.78
	15,IIA	4,IIA
P_2	5349.71	5301.94
	18687.41	18855.78
144.76		
		10,IIA
P_1		5342.96
		18711.02
	6,IA	1,IIA
D_3	6258.97	6193.66
	15972.65	16141.09
44.20		
	3,IIA	6,IA
D_2	6276.33	6210.86
	15928.49	16096.84
	50,IA	10,IIA
D_3	6305.69	6239.40
	15854.31	16022.77
0.9		
	10,IA	20,IA
D_2	6305.99	6239.78
	15853.56	16021.79
	6,IA	2,IIA
D_3	6413.37	6344.84
	15588.12	15756.50
83.96		
	I,IIA	5,IA
D_2	6448.10	6378.83
	15504.17	15672.54

2. *Spark spectrum of scandium* (ScII). The wave lengths and intensities of scandium spark lines classified in table 2 are from unpublished values determined by the writer, while the temperature classes and enhanced symbols are from King's work. The ultra-violet multiplet of six lines (2540.87—2563.23A) was properly named by Popow[8] in 1914. In 1922, Catalán published six additional multiplets but the types of terms were misnamed in three of these. The correct identification of the terms was suggested to me by Professor

[8] Popow, Ann. d. Physik. **45**: 163. 1914.

TABLE 2.—TRIPLETS IN THE SPECTRUM OF ScII

	D_3	109.97	D_2	67.65	D_1
F_4	60, II 3613.84u_1 27663.56				
238.86					
F_3	30, III 3645.31 27424.70		50, II 3630.76u_2 27534.65		
158.72					
F_2	3, III 3666.54 27265.96		25, III 3651.80 27376.01		40, II 3642.79 27443.68
D_3	50, II 3572.53 27983.40		20, II 3558.55 28093.37		
139.82					
D_2	20, II 3590.48 27843.53		35, II 3576.35 27953.55		20, II 3567.70 28021.25
103.52					
D_1			20, II 3589.64 27850.01		30, II 3580.94 27917.73
P_2	20, III 3372.14 29646.24		10, III 3359.68 29756.24		3, IV 3352.08 29823.95
81.80					
P_1			15, III 3368.94 29674.44		10, III 3361.26 29742.20
5.94					
P_0					12, III 3361.94 29736.23
P_2	10 2552.38 39167.41		5 2545.24 39277.21		1 2540.87 39344.74
230.39					
P_1			9 2560.26 39046.84		6 2555.84 39114.33
112.74					
P_0					8 2563.23 39001.59

TABLE 2.—Triplets in the Spectrum of ScII—*Continued*

	F_4	104.21	F_3	80.68	F_2
F_4	40, III E 4374.46 22853.57		5, V E 4354.60 22957.79		
238.86					
F_3	2 4420.66 22614.72		30, III E 4400.38 22718.92		6, IV E 4384.80 22799.65
158.72					
F_2			3, V E 4431.35 22560.17		20, III E 4415.55 22640.91
D_3	60, III E 4314.09 23173.39		8, IV E 4294.77 23277.60		1 4279.95 23358.20
139.82					
D_2			50, III E 4320.73 23137.76		10, IV E 4305.71 23218.43
103.52					
D_1					40, III E 4325.00 23114.93
	P_2	52.94	P_1	27.46	P_0
D_3	25, V E 6245.64 16006.73				
139.82					
D_2	8 6300.70 15866.87		20 6279.74 15919.84		
103.52					
D_1	1 6342.08 15763.34		8 6320.86 15816.28		15 6309.90 15843.74
P_2	25, V E 5657.89 17669.55		15, V E 5640.99 17722.48		
81.80					
P_1	12, V E 5684.21 17587.72		9, V E 5667.16 17640.65		8, V E 5658.35 17668.10
5.94					
P_0			10, V E 5669.05 17634.75		

Russell, and although as stated above there are as yet no published Zeeman-effect data for scandium, comparison with the spectral structure of YII for which such data exist, and general consideration of the various rules which govern multiplet structures, leave no further doubt as to the naming of these terms.

The lowest energy level in the ionized scandium atom is represented by the D term with separations of 67.65 and 109.97; the *raies ultimes*,[9] marked u_1, and u_2 occur in a DF combination.

Lines probably belonging to the singlet spectral system are recognized in the scandium spark but they have not yet been classified. The presence of singlet and triplet systems in ScII makes this spectrum resemble the arc spectrum of the preceeding element, calcium, in accordance with the displacement law of Kossel and Sommerfeld.

3. *Arc spectrum of yttrium* (YI). Since the spectra of yttrium are expected to be similar in structure to those of scandium it is not surprising to find that most of the stronger arc lines of yttrium originate in combinations of doublet terms. The lowest level in the spectrum of neutral yttrium is a doublet D term with the separation 530.35. No results of temperature classification or of absorption observations in this spectrum have been published but the fact that many of the lines involving this D level appear strongly enhanced in the Mt. Wilson Observatory map of the sun-spot spectrum is good evidence that it is the lowest level. It is strictly analogous to the doublet term established by the absorption observations of Gieseler and Grotrian to be the lowest level in ScI. A partial list of the combinations of this low D level with other terms in the yttrium arc spectrum is given in table 3, and the data for Zeeman effect of these lines are reproduced in table 5.

TABLE 3.—DOUBLETS IN THE SPECTRUM OF YI

	D_3	530.35	D_2
	20		3
P_2	3620.94		3552.69
	27609.29		28139.69
314.99			
			10
P_1			3592.91
			27824.70

[9] de Gramont, Comptes Rendus 171: 1106. 1920.

TABLE 3.—DOUBLETS IN THE SPECTRUM OF YI—*Continued*

P_2?	30 4128.32 24216.13	5 4039.83 24746.53
47.79		
P_1		8 4047.65 24698.74
P_2	8 4174.14 23950.31	8 4083.71 24480.64
349.54		
P_1		20 4142.87 24131.10
F_4	20 4102.38 24369.26	
380.91		
F_3	10 4167.52 23988.35	20 4077.39 24518.58
F_4	10 4674.84 21385.16	
386.99		
F_3	5 4760.99 20998.17	10 4643.70 21528.53
D_3?	6 6402.02 15615.75	15 6191.73 16146.13
80.08		
D_2?	15 6435.03 15535.66	10 6222.58 16066.05
D_3?	4 6793.72 14715.50	3 6557.44 15245.83
296.82		
D_2?	3 6933.56 14418.70	6 6687.57 14948.98

4. *Spark spectrum of yttrium* (YII). Two multiplets of the type D^3P^3 were published by Popow[10] in 1914. These and additional groups in the triplet system are collected in table 4. So far as these groups are concerned, it is evident from tables 2 and 4 that the spectrum of YII is exactly analogous to that of ScII. The sublevels of yttrium terms are more widely separated than those of scandium and the corresponding multiplets are displaced toward the red. Three sets of P terms having been found in ScII at least as many would be expected in YII, but in the latter case the multiplets involving the low P level

TABLE 4.—TRIPLETS IN THE SPECTRUM OF YII

	D_3	404.8	D_2	204.9	D_1
F_4	100 3710.30u_1 26944.37				
861.6					
F_3	20 3832.87 26082.76		50 3774.33u_2 26487.26		
305.4					
F_2	4 3878.27 25777.44		10 3818.37 26181.79		30 3788.69 26386.90
D_3	50 3600.72 27764.36		20 3548.99 28169.01		
484.0					
D_2	20 3664.59 27280.44		30 3611.05 27684.88		10 3584.51 27889.88
134.7					
D_1			10 3628.70 27550.26		20 3601.91 27755.19
P_2	20 4309.61 23197.44		6 4235.71 23602.16		3 4199.28 23806.92
870.9					
P_1			15 4398.03 22731.10		8 4358.72 22936.10
331.3					
P_0					10 4422.60 22604.80

[10] Popow, Ann. d. Physik. 45: 163. 1914.

TABLE 4.—TRIPLETS IN THE SPECTRUM OF YII—*Continued*

P_2	20 3242.28 30833.64		8 3200.25 31238.58		5 3179.40 31443.37
159.5					
P_1			10 3216.67 31079.07		8 3195.61 31283.93
75.3					
P_0					8 3203.32 31208.64
	F_4	415.4	F_3	324.9	F_2
F_4	10 5087.42 19650.92		3 4982.12 20066.18		
861.6					
F_3	1 5320.77 18789.04		10 5205.71 19204.36		3 5119.10 19529.26
305.4					
F_2			2 5289.81 18899.02		8 5200.41 19223.93
D_3	50 4883.69 20470.62		5 4786.57 20885.98		1 4713.26 21210.85
484.0					
D_2			30 4900.11 20402.05		10 4823.32 20726.85
134.7					
D_1					30 4854.88 20592.10
	P_2	79.8	P_1	−79.8	P_0
D_3	20 6613.74 15115.87				
484.0					
D_2	5 6832.47 14631.96		15 6795.40 14711.78		
134.7					
D_1	? 6895.99 14497.19		5 6858.22 14577.04		10 6895.99 14497.19

TABLE 4.—TRIPLETS IN THE SPECTRUM OF YII—*Continued*

P_2	10708.4	10628.6	
870.9			
P_1	9837.5	9757.8	9837.5
331.3			
P_0		9426.5	

would probably appear in the red or infra-red. A special search for these was made with sensitized photographic plates, and a group of enhanced lines was found between 6613.74 and 6895.99A. These have been arranged in a PD multiplet which, if correct, indicates that P_0 and P_2 are coincident. The combination of this level with the higher P level (separations 331.3 and 870.9) should give a multiplet in the infra-red. This one, however, is just outside the region which is accessible to photography, so there is at present no way to verify the abnormal P term. The remaining terms are all established by the Zeeman-effect data collected in table 6. The lowest level in ionized yttrium is the D term with separations 204.9 and 404.8; the *raies ultimes*, marked u_1 and u_2 appear in a DF combination.

In addition to the triplet-system multiplets here presented, two pairs have been recognized as combinations between the triplet and singlet systems. These are 3747.55, 3776.58A (P^1D^3), and 3950.35, 3982.60A (D^1D^3). The relative values of other singlet terms have not been satisfactorily arranged as yet. Extended results of investigations on the spectra of scandium and yttrium will appear later in Scientific Papers of the Bureau of Standards.

TABLE 5.—ZEEMAN EFFECT FOR YI

Terms	λI.A.	*Obs.*	*Calc.*
D_2P_2	3552.69	(0.78) ——	(0.00, 0.80) 0.53, 1.06, 1.60
D_2P_1	3592.91	(0.00) 0.79	(0.07) 0.73, 0.87
D_3P_2	3620.94	(0.00) 1.00	(0.07, 0.20) 1.00, 1.14, **
D_2P_2	4039.83	(0.00) 1.37	(0.00, 0.80) 0.53, 1.06, 1.60
D_2P_1	4047.65	(0.00) 0.75	(0.07) 0.73, 0.87
D_3P_2	4128.32	(0.25) 1.10	(0.07, 0.20) 1.00, 1.14, **
D_2P_2	4083.71	(0.73) 0.55, 0.98, 1.55	(0.27, 0.80) 0.53, 1.06, 1.60
D_2P_1	4142.87	(0.00) 0.80	(0.07) 0.73, 0.87
D_3P_2	4174.14	(0.00) 1.09	(0.07, 0.20) 1.00, 1.14**
D_2F_3	4077.39	(0.00) 1.06	(0.03, 0.09)** 0.89, 0.94
D_3F_4	4102.38	(0.00) 1.07	(0.03, 0.09*) 1.00, 1.06, 1.12***
D_3F_3	4167.52	(0.52) 1.05	(*0.51, 0.86)* 0.69, 1.03, 1.37*
D_2F_3	4643.70	(0.00) 0.89	(0.03, 0.09)** 0.89, 0.94
D_3F_4	4674.84	(0.00) 1.05	(0.03, 0.09*) 1.00, 1.06, 1.12***

TABLE 6.—ZEEMAN EFFECT FOR YII

Terms	λ I.A.	*Obs.*	*Calc.*
D_2P_2	3200.25	(0.60) 1.34	(0.33, 0.67) 0.83, 1.17, 1.50, 1.83
D_2P_1	3216.67	(0.00) 0.98	(0.00, 0.33) 0.83, 1.17, 1.50
D_3P_2	3242.28	(0.00) 1.16	(0.00, 0.17*) 1.00, 1.17, 1.33**
D_2D_3	3548.99	(0.00) 1.46	(0.00, 0.17*) **1.33, 1.50, 1.67
D_1D_2	3584.51	(0.00, 0.65) 0.47, 1.15, 1.81	(0.00, 0.67) 0.50, 1.17, 1.83
D_3D_3	3600.72	(0.00) 1.29	(0.00) 1.33
D_1D_1	3601.91	(0.00) 0.54	(0.00) 0.50
D_2D_2	3611.05	(0.00) 1.14	(0.00) 1.17
D_2D_1	3628.70	(0.00, 0.58) 0.55, 1.12, 1.68	(0.00, 0.67) 0.50, 1.17, 1.83
D_3D_2	3664.59	(0.00) 1.52	(0.00, 0.17*) **1.33, 1.50, 1.67
D_3F_4	3710.30	(0.00) 1.09	(0.00, 0.08**) 1.00, 1.08, 1.17****
D_2F_3	3774.33	(0.00) 1.00	(0.00, 0.08*) 0.92, 1.00, 1.17*
D_1F_2	3788.69	(0.00) 0.89	(0.00, 0.17) 0.50, 0.67, 0.83
D_2F_2	3818.37	(0.38, 0.77) 0.37, 0.74, 1.14, 1.52	(0.50, 1.00) 0.17, 0.67, 1.17, 1.67
D_3F_3	3832.87	(0.61) 1.17	(*0.50, 0.75) **1.08, 1.33**
D_2P_2	4235.71	(0.31, 0.62)—	(0.33, 0.67) 0.83, 1.17, 1.50, 1.83
D_3P_2	4309.61	(0.00) 1.16	(0.00, 0.17*) 1.00, 1.17, 1.33**
D_1P_1	4358.72	(0.96) 0.47, 1.44	(1.00) 0.50, 1.50
D_1P_0	4422.60	(0.00) 0.47	(0.00) 0.50
F_2D_1	4854.88	(0.00) 0.80	(0.00, 1.17) 0.50, 0.67, 0.83
F_4D_3	4883.69	(0.00) 1.08	(0.00, 0.08**) 1.00, 1.08, 1.16****
F_3D_2	4900.11	(0.00) 0.96	(0.00, 0.08*) 0.92, 1.00, 1.08**
F_4F_4	5087.42	(0.00) 1.17	(0.00) 1.25
F_2F_2	5200.41	(0.00) 0.65	(0.00) 0.67
F_3F_3	5205.71	(0.00) 1.03	(0.00) 1.08

ZOOLOGY.—*New species of* Ferrissia *from Lower California.* BRYANT WALKER. (Communicated by PAUL BARTSCH.)

I am indebted to Dr. Paul Bartsch of the U. S. National Museum for the opportunity of examining a small lot of Ancylids collected by him in a small pool two and one-half miles inland from San José del Cabo, Lower California. It was found that two very distinct species were represented in the collection, both of which belong to *Ferrissia s. s.* The occurrence of the typical group of this genus so far south was quite a surprise as all of the Mexican species, so far as they have been examined as to apical sculpture, belong to the subgenus *Lael-*

papex. *Ferrissia s. s.*, however, is found all along the west coast of the United States, and the colony at San José, no doubt, represents a southern extension of the northern fauna.

Ferrissia bayacalifornica, n. sp. (fig. 1)

Shell pale corneous, thin, obovate, the greatest width being at about the anterior third of the length; anterior margin broadly rounded; posterior margin regularly rounded, but slightly compressed on the right side; lateral margins about equally curved, the left somewhat more so; apex acute, scarcely depressed at the tip, situated at about one mm. from the posterior margin and decidedly turned to the right, radially striate; anterior slope nearly straight, slightly curved towards the apex; posterior slope oblique and nearly straight below the projecting apex; left lateral slope slightly, but regularly

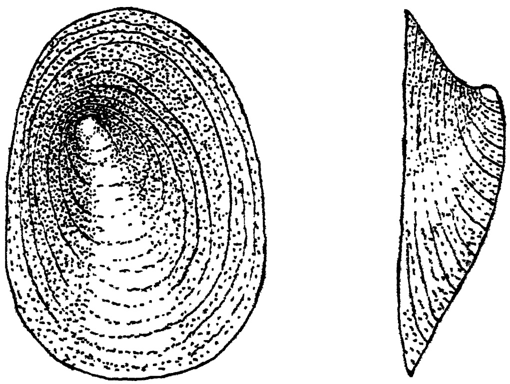


Fig. 1.—*Ferrissia bayacalifornica*, much enlarged.

curved from the apex to the lateral margin; right lateral slope slightly incurved at the base of the apex and thence obliquely straight to the lateral margin; surface with fine and regular growth-lines and very faint, scarcely perceptible indications of radial rippling on the anterior slope towards the margin.

Length 4.75; width 3.4; alt. 1.4 mm.

Type.—No. 264600, U. S. National Museum. Paratypes in Coll. Walker (no. 77862).

This species in its obovate shape and acute apex differs very distinctly from any of the described species of *Ferrissia s. s.*

Ferrissia occidentalis, n. sp. (fig. 2)

Shell pale greenish horn color, thin, nearly oval, slightly wider anteriorly anterior and posterior margins regularly rounded; lateral margins about equally curved; apex very obtuse, situated at the posterior fourth of the length, somewhat turned to the right, radially striate; anterior slope regularly but not strongly curved from the apex to the anterior margin; posterior slope oblique and slightly incurved; left lateral slope slightly convex; right lateral slope somewhat incurved; surface with very fine and regular growth-lines and without radial sculpture.

Length 4; width 2.5; alt. 1.25 mm.

Type.—No. 361553, U. S. National Museum. Paratypes in Coll. Walker (no. 77863).

This species differs from the preceding in its smaller size, oval shape and obtuse apex and these features serve to distinguish it from any of the other described species.

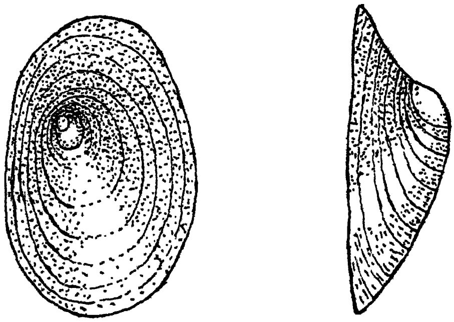


Fig. 2.—*Ferrissia occidentalis*, much enlarged.

ENTOMOLOGY.—*The American Species of Thaumalidae (Orphnephilidae) (Diptera).* HARRISON G. DYAR and RAYMOND C. SHANNON, U. S. National Museum (Communicated by S. A. ROHWER).

The Thaumalidae are a small group of obscure little flies, usually found in hilly, heavily wooded country around the moss-covered banks of very shallow streams and springs. They have been very rarely collected in North America, our previous records being confined to New York State only.

In 1913 Bezzi pointed out[1] that the single known American species of this family, which had previously been considered conspecific with the European *Orphnephila testacea* Ruthé (See L. G. Saunders[2]), was distinct, and for it proposed the name *Thaumalea americana.* Several additional American species are at present represented in the collection of the U. S. National Museum.

The family Thaumalidae holds a unique place in the classification of the nematocerous Diptera. Its exact position is uncertain, because of a number of peculiar structural characters.

The wing venation according to the Comstock-Needham system is as follows: The costa continues around the wing to its tip, where it is

[1] Boll. Lab. Zool. R. Scuola d'Agr. Portici 7: 227–266. 1913.
[2] Ann. Mag. Nat. Hist. ser. 9, 11: 631–640. 1923.

much weaker beyond R_{4+5} (third longitudinal); the subcosta is usually weak, sometimes evanescing before its tip; the Sc-R cross-vein is placed at about the middle of the subcostal; R_1 joint costal beyond middle of wing; the radial sector forks about opposite the tip of subcostal; with branch R_{4+5} forking a short distance beyond; R_2 joins R_1 a short distance beyond the fork of R_{4+5} and appears as a cross-vein, thus making a small first R_1 cell; R_3 and R_{4+5} are nearly parallel and extend to tip of wing; R-M cross-vein is near the base of the forking of R_{4+5}; the media is reduced to a single branch; M-Cu·cross-vein present, making a second basal cell; Cu_1 and Cu_2 both present; anal vein absent.

The antenna has been somewhat indefinitely described. It consists of a scape, pedicel, and flagellum, the latter being very compact and arista-like, but composed of ten distinct joints, the basal two rather large and globose.

A peculiar phenomenon occurs in the males of several of the families of Nematocera. Shortly after the emergence of the adult, the tip of the abdomen beyond the seventh segment undergoes a rotation through an angle of 180°. The Thaumalidae, however, do not undergo this change, as is evidenced by the ventral position of the side-pieces and claspers.

The adults, furthermore, present a very unusual condition by lacking spiracles in the second and third abdominal segments.

KEY TO AMERICAN SPECIES OF THAUMALEA

Subcostal vein of wing obsolete on its apical part.........1. *pluvialis*, n. sp.
Subcostal vein distinct apically where it joins costa.
  Darkly colored species, the mesonotum dark brown; abdomen and pleurae nearly black.
    Male clasper with two terminal claws; terminal abdominal hairs long; tenth sternites parallel sided..................2. *americana* Bezzi.
    Male clasper with about six terminal claws; terminal abdominal hairs shorter and spine-like; tenth sternites spatulate at tip.....................................3. *johannis*, n. sp.
  Pale colored species, the mesonotum and pleurae light testaceous; abdomen brown.....................................4. *elnora*, n. sp.

1. **Thaumalea pluvialis,** new species.

A dark brown medium sized species. Mesonotum thickly clothed with very small hairs; margin of scutellum with several rows of minute setae. Legs dark brown. Wings strongly infuscated; in addition to the usual villae, clothed with numerous hair-like setulae. Subcosta faint beyond Sc-R cross vein, its apex entirely evanescent; R_2 about five times its length distant from base of fork of R_{4+5}; R_3 slightly curved, nearly parallel with R_{4+5}. Halteres and abdomen dark brown. Length 2.5 mm.

Male hypopygium. Ninth segment convex and chitinized dorsally, not enclosing the side-pieces, which fit in beneath it. Side piece ovate, a little longer than wide, the tip notched for the reception of the clasper; many spiny

setae at the tip. Clasper slender, parallel sided, a little swollen in the middle, with about 14 terminal claws and three stout spines, the latter inserted in an oblique row on the outer fourth of the clasper. A triangular weakly chitinized piece at base of side piece and not as long as its width may represent the tenth sternites.

Types, two males, no. 27460, U. S. Nat. Mus.; Prince Rupert, British Columbia, Canada, June 17, 1919 (*H. G. Dyar*).

2. **Thaumalea americana** Bezzi.

Male hypopygium. Ninth segment covering the hypopygium, the paired flaps beyond it with long setae. Side piece conical, as broad as long, strong excavate at tip for the insertion of the clasper, with coarse hairs outwardly and beneath. Clasper short, tapering, with two terminal claws. Tenth sternites with triangular base, curved, parallel-sided and rounded tips.

Our localities for this species are as follows:

NEW YORK: Ithaca, August 30, 1901 (*O. A. Johannsen*).

PENNSYLVANIA: Pequea, August 31, 1924 (*R. C. Shannon*).

WEST VIRGINIA: Cheat Mountain Cave, File Creek (*D. H. Clemons*).

3. **Thaumalea johannis,** new species.

Rather small dark brown species with smoky wings. Last two palpal joints slightly shorter than flagellum. Scutellum with a single row of marginal setae. Legs dark brown. Subcosta complete, joining costa just before base of Rs. R_2 placed about four times its length from base of fork of radius sector. R_3 gently and evenly curved, its tip approaching R_{4+5}. Cu_2 gently curved forwards. Wings with villae only. Halteres and abdomen dark brown.

Male hypopygium. Ninth segment broad, covering the hypopygium, the paired flaps beyond it with short spine-like setae. Side piece conical, as broad as long, strongly excavate at tip for insertion of clasper, with coarse hairs outwardly and beneath. Clasper short, tapering, hairy, with about six terminal claws. Tenth sternites with triangular base, oblique, distinctly constricted before the tips.

Types, two males, no. 27461, U. S. Nat. Mus.; Cabin John, Maryland, March 24, 1915, April 14, 1916 (*R. C. Shannon*).

4. **Thaumalea elnora,** new species.

Entirely yellow, except for reddish brown abdomen. Last two palpal joints noticeably longer than flagellum. Scutellum with two irregular rows of setae. Sc-R cross vein before the middle of humeral cross-vein and tip of subcosta; subcosta ending beyond base of radial sector; R_2 about twice its length from base of R_{4+5}; R_3 rather strongly bowed and approaching tip of R_{4+5}; M-Cu cross-vein opposite base of Rs, two and a half times as long as R-M cross-vein. Wing faintly smoky. Halteres and cerci of female bright yellow.

Male hypopygium. Ninth segment broad, slightly more heavily chitinized than the preceding ones, the pair of flaps beyond it (tenth tergites) finely setose. Side piece conical, about as long as broad, sparsely and coarsely setose. Clasper conical, setose, with two claws at tip. Tenth sternites with triangular base, curved, long, thickened at tip and recurved in a hook.

Types, male and female, no. 27462, U. S. Nat. Mus.; Moscow Mountain, Idaho, July 25, 1920 (*R. C. Shannon*). Dr. A. L. Melander was the first to discover the habitat of this species.

It gives us pleasure to name this species for Miss Elnora M. Sutherlin.

# JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 NOVEMBER 19, 1924 No. 19

GEOPHYSICS.—*The radial distribution of certain elements in the Earth.*[1] HENRY S. WASHINGTON. Geophysical Laboratory, Carnegie Institution of Washington.

According to the generally accepted geophysical theory the Earth is constituted—speaking broadly—of a central core of nickel-iron, surrounded by a thick shell of stony matter, the thin, outermost, solid, and crystalline skin of which is called the "crust." This general concept of the distribution of matter in the Earth is more or less varied in detail, according to individual views as to the data to be considered as fundamental and the different interpretations of them.[2]

In recent papers[3] a fairly detailed distribution of matter, both in composition and in depth, has been suggested, which is based on what is known of the relations of the velocity of earthquake waves to depth, the distribution of density, the compressibility of minerals and rocks,[4] the petrology of igneous rocks, and, especially, on analogy with meteorites. This distribution, which is in general accord with that suggested by several others (Suess, Wiechert, Gutenberg, and Clarke), is characterized by a striking distribution of certain elements,

[1] Received October 20, 1924.

[2] For an exposition of what is known as to the interior of the Earth and a resumé of the various theories as to the distribution of matter within it, see a forthcoming paper, *The interior of the Earth and its relation to the crust*, to be published in Journ. Franklin Inst. 1925.

[3] WILLIAMSON and ADAMS. *Density distribution in the Earth.* This JOURNAL **13**: 413. 1923; F. W. CLARKE. *The evolution and disintegration of matter.* U. S. Geol. Survey, Prof. Paper 132-D, 76. 1924; ADAMS and WASHINGTON. *The distribution of iron in meteorites and in the Earth.* This JOURNAL **14**: 333. 1924; ADAMS and WILLIAMSON. *The composition of the Earth's interior.* Smithsonian Inst., Ann. Rep. 1923: (in press).

[4] ADAMS and WILLIAMSON. *The compressibility of minerals and rocks at high pressures.* Journ. Franklin Inst. **195**: 475. 1923.

notably oxygen and silicon, from the center to the surface, to which it is the purpose of this note to call attention. Such details as the depth and the thickness, and the physical characters, of the several shells, will not be considered here.

The central "core," composed of nickel-iron, as are the sideritic meteorites, contains neither oxygen nor silicon; on the contrary, non-oxide compounds—phosphides, carbides, and sulphides—are probably present in considerable amount. Compounds of aluminum, calcium, sodium, and potassium are also wholly lacking.

Near the border of the iron core silicon and oxygen, as silicate, enter into the composition, the amount gradually increasing outward, so as to form a spherical shell or "sphere" of mixed nickel-iron and silicate, in which the silicate is sporadic, that is to say, scattered as discrete particles in a continuum of iron, the texture being in general like that of meteoritic pallasite.[5] The silicate in this shell, from analogy with meteorites, is mostly olivine, an orthosilicate of iron and magnesium, 2 $(Fe, Mg)O. SiO_2$; with none, or subordinate amounts, of the metasilicate pyroxene, $(Fe, Mg)O.SiO_2$. In this "lithosporic" shell the silicate and metal are present on the average, or near the middle of the shell, in approximately equal amounts, the metal content gradually diminishing outwardly.

This "lithosporic" shell, in turn, passes gradually into a "ferrosporic" shell, one in which the nickel-iron is sporadic in a continuum of silicate, the silicate being a mixture of olivine and pyroxene. The metallic content is here greatly diminished, being, on the average probably not over about 15 per cent. Some non-oxide compounds, phosphides and sulphides, are probably also present in small amount in both these shells. Through a gradual diminution in the amount of nickel-iron this shell merges into an outer shell composed almost wholly of silicates, these being mostly pyroxene and olivine, in which (again from analogy with meteorites), the amount of pyroxene is greater than that of olivine. This material corresponds to the achondritic meteorites. There may be present also a little anorthite, orthosilicate of aluminum and calcium. The non-silicates present are mostly oxides, especially magnetite and chromite, probably with sulphides, borides, and nitrides.

Above this shell lies the "crust," probably about 60 kilometers thick—certainly not over about 100 kilometers, as is indicated by

[5] Cf. ADAMS and WASHINGTON. *The distribution of iron in meteorites and in the Earth.* This JOURNAL 14: 333. 1924. The terms "lithosoporic" and "ferrosporic" are here proposed and defined.

several convergent lines of evidence, thermal, seismic, isostatic, petrologic, etc. The material of the lower part of the "crust" is supposed to be in general gabbroic or basaltic, that is to say, a mixture of pyroxene and soda-lime feldspar, which may be typified as labradorite, a mixture of orthosilicate anorthite ($CaO \cdot Al_2O_3 \cdot 2SiO_2$), and polysilicate albite ($Na_2O \cdot Al_2O_3 \cdot 6SiO_2$), in about equal parts. Probably a little olivine is present, and there is a little magnetite (Fe_3O_4). In the lower part of the crust, therefore, aluminum and calcium, which have been almost negligible below, become abundant, and sodium, which was scarely present below, here becomes a prominent constituent. In the lower part of the "crust" there is almost certainly no, or only a negligible amount of, potassium and excess silica. Potassium and excess silica begin to come in toward the upper part of the "crust," in the forms of polysilicate orthoclase ($K_2O \cdot Al_2O_3 \cdot 6SiO_2$), and quartz ($SiO_2$), until near the surface they are the most abundant minerals, along with dominantly sodic plagioclase, andesine, and oligoclase. In this upper part, which may be approximately 15 to 20 kilometers thick, the material is overwhelmingly granitic or granodioritic in the continental masses, the material of the ocean floors being essentially basaltic.[6] In this outermost, granitic shell, furthermore, the relative amount of iron-magnesium silicate has greatly diminished, and is mostly biotite and hornblende, with augite and other pyroxenes, the general excess of silica precluding the presence of orthosilicate olivine in notable amount, except more or less locally, as in flows of olivine basalt and such rocks.

Finally, oxygen is abundant in the hydrosphere and is free in the lower part of the all-enveloping atmosphere.

Several independent, convergent, and mutually corroborative lines of evidence indicate that the above described distribution of matter in the Earth is approximately correct or, at least, very probably true in its broad lines. The details of the evidence cannot be discussed here; they will be found set forth at length in the forthcoming paper referred to above. Granted that such is the true, or approximately true, state of affairs within the Earth, it follows that there is a progressive increase in the relative amount of certain elements and an inverse progressive decrease in the relative amount of others, from the center to the surface of the Earth.

[6] For the average composition of the continental masses, the ocean floors, and smaller areas, see CLARKE and WASHINGTON. *The average chemical composition of igneous rocks.* Proc. Nat. Acad. Sci. **8**: 108–115. 1922; WASHINGTON. *Isostasy and rock density.* Bull. Geol. Soc. America **33**: 388. 1922; CLARKE and WASHINGTON. *The composition of the Earth's crust.* U. S. Geol. Survey, Prof. Paper 127, 13–15, 42–69. 1924.

Speaking generally, not only does the relative amount of silicates increase from the center outward, but the degree of silication increases in the same sense. Near the central, metallic core these compounds are all or mostly orthosilicate, then come mixtures of orthosilicate and metasilicate, then mostly metasilicate, all of these silicates of iron and magnesium, with probably some calcium-aluminum orthosilicate (anorthite) toward the top. Then sodic polysilicate enters, balancing the calcic orthosilicate so far as the relative silica content is concerned; next polysilicates are dominant; and finally there is abundant excess or free silica with alkali polysilicates, both together largely dominant over gradually diminishing metasilicate, and with ortho-

TABLE 1.—The Percentages of Silica, Silicon, and Oxygen in Minerals

MINERAL	SILICA	SILICON	OXYGEN
Fe_2SiO_4	29.4	13.7	31.4
$Fe_2SiO_4 + Mg_2SiO_4$ (1:1)	**36.2**	**16.9**	**38.6**
Mg_2SiO_4	42.9	20.0	45.7
$(Fe, Mg)_2SiO_4 + (Fe,Mg)SiO_3$ (1:1)	**44.2**	**20.8**	**40.4**
$FeSiO_3$	45.5	21.2	36.4
$FeSiO_3 + MgSiO_3$ (1:1)	**52.8**	**24.6**	**42.2**
$MgSiO_3$	60.0	28.0	48.0
$CaAl_2Si_2O_8$	43.2	20.1	46.4
$(Fe,Mg)SiO_3 + CaAl_2Si_2O_8$ (1:1)	**48.0**	**22.4**	**44.3**
$CaAl_2Si_2O_8 + NaAlSi_3O_8$ (1:1)	**55.9**	**26.1**	**47.6**
$CaAl_2Si_2O_8 + NaAlSi_3O_8$ (1:3)	**62.3**	**29.1**	**48.2**
$NaAlSi_3O_8$	68.7	32.1	48.8
$KAlSi_3O_8$	64.7	30.2	46.4
$KAlSi_3O_8 + SiO_2$ (1:1)	**73.5**	**34.3**	**47.8**
SiO_2	100.0	46.7	53.3

silicate practically absent. Inverse to this progressive increase in silica is the progressive diminution in nickel-iron, in silicates of iron and magnesium, and probably also in non-oxide compounds.

As a consequence of the progressive increase in silica, there is also progressive increase in the relative amounts of silicon and oxygen from the center outward. The progression of the three constituents, silica, silicon, and oxygen, is to be seen in the accompanying tables 1 and 2, in which are given their percentages in, respectively, the principal minerals and some ideal mixtures of them, and in the assumedly average successive shells, from the center to the surface (reading downward). Because of the great difference in the atomic weight of iron and magnesium, and consequently in the molecular weight of their homologous silicates and in the percentage of silica

in these, the progression is best seen if mixtures[7] of the ortho- or metasilicates of the two elements (for convenience in equal amount) are compared with each other and with the feldspars.

More detailed consideration of the general distribution shows that, superposed on the two inverse progressions (of silicates and of nickel-iron) are progressions in the basic elements of the silicates. Iron and magnesium (as silicates) increase at first from the border of the nickel-iron core until they reach a maximum in the metal-free (achondritic) shell, composed essentially of olivine and pyroxene. Above this they steadily decrease until they are almost (or quite) negligible in the granitic upper part of the "crust," represented by the continental

TABLE 2.—THE PERCENTAGES OF SILICA, SILICON, AND OXYGEN IN THE EARTH SHELLS

SHELL	SILICA	SILICON	OXYGEN
Nickel-iron core	0.0	0.0	0.0
Lithosporic shell[1]	18.1	8.5	19.3
Ferrosporic shell[2]	35.4	16.6	32.3
Metal-free shell[3]	44.2	20.8	40.4
Lower part of "crust"[4]	48.0	22.4	44.3
Upper part of "crust"[5]	59.1	27.7	46.6

[1] Olivine: nickel-iron = 1:1.
[2] Pyroxene + olivine: nickel-iron = 4:1.
[3] Pyroxene: olivine = 1:1.
[4] Pyroxene: anorthite = 1:1.
[5] According to Clarke and Washington.

masses. It is unknown whether there is any concomitant progressive change in the ratios between the two: it would seem to be probable that there is such a variation, but time is lacking at present for proper study of this phase of the subject.

The evident progression in the relative amounts of calcium, sodium, and potassium, is also of interest. Calcium begins to appear in the upper part of the ferrosporic pyroxene-olivine shell, accompanied by very small amounts of sodium, and without any potassium. The relative amount of calcium reaches a maximum in the lower, basaltic part of the "crust," where it forms part of both pyroxene and feldspar. Here sodium begins to assume important proportions, its amount increasing gradually upward, while the amount of calcium decreases almost inversely. Finally, with the appearance of potassium, probably about the middle of the crustal shell, the amount of calcium be-

[7] Mixtures are indicated by bold-faced type.

comes very small. From this point upward the alkali metals largely dominate over calcium, potassium at the same time gradually increasing over sodium, and excess silica becoming abundant.

The upward progression of aluminum is determined largely by the fact that in the chief minerals of which it is a constituent (anorthite, albite, orthoclase) it is present in equal molecular amount with the bases calcium, sodium, and potassium, except for the small amount present in augite (probably in solid solution), in hornblende, and as an essential part of the molecule in biotite and muscovite. These minerals (augite, hornblende, and micas), however, appear to be formed only under the conditions that control in the upper part of the "crust."

The elements that have been considered in this discussion of progressions are all, with the exception of nickel, those that are most abundant in the "crust" of the Earth, of which they together make up 98.6 per cent.[8] These elements and their percentages, in the order of abundance, are: oxygen 46.59, silicon 27.72, aluminum 8.13, iron 5.01, calcium, 3.63, sodium 2.85, potassium 2.60, magnesium 2.09. The amount of iron has decreased from about 91 per cent to 5 per cent; while the amount of nickel, which in the central core amounts to probably about 8.5 per cent,[9] has diminished at the surface to 0.02 per cent.[8] Similarly, the amount of magnesium has dropped from its maximum of about 13 per cent in the pallasitic shell to 2 per cent in the crust. The effects of the several progressions are thus clearly evident.

A noteworthy feature of the progressions outlined above is that they follow in the order of what has been called the "affinity for silica" of the most abundant oxides (except alumina).[10] This order is: $K_2O > Na_2O > CaO > MgO > FeO$. Thus, one molecule of potash and soda can bind up to six molecules of silica, one of lime up to two of silica, one of magnesia up to one of silica and one of ferrous oxide up to one of silica and ferrous oxide, can exist in rocks (as magnetite $FeO. Fe_2O_3$) uncombined with free silica.

Also, this order is the order of oxidizability of the metals concerned. The very ready oxidizability of the alkali metals is well known,

[8] CLARKE and WASHINGTON. *The composition of the Earth's crust.* U. S. Geol. Survey, Prof. Paper 127, 20. 1924.

[9] Cf. FARRINGTON. *Analyses of stone meteorites.* Field Mus. Publ. 151: 212. 1911.

[10] Cf. WASHINGTON. *The chemistry of the Earth's crust.* Journ. Franklin Inst. 190: 791. 1920; CLARKE and WASHINGTON. *The composition of the Earth's crust.* U. S. Geol. Survey, Prof. Paper 127, 100. 1924.

potassium being somewhat more easily oxidizable than sodium; calcium is fairly stable in the air, but oxidizes slowly; magnesium is much more stable in the air than is calcium, but a wire or ribbon of it burns readily; iron is quite stable in the air, much more so than magnesium—a thin wire or ribbon of it cannot readily be burned.

In other words, the order of characteristic occurrence of the elements from the surface to the center is that of the positions of the respective metals of the electrochemical series, namely: K, Na, Ca, Mg, (Al), Fe, Ni. Tammann[11] has also expressed the idea that the elements in the Earth are arranged generally, from the surface to the center in the order of their electro-affinity, from the most electropositive to the most electronegative, those that are more electropositive than iron forming the crust.

Such a general distribution as has been suggested above has been often compared to the slag and metal in iron smelting, or the metal, matte, and slag in the smelting of copper. Indeed, Goldschmidt[12] and Tammann[13] carry this latter comparison to the extent of suggesting the presence of a shell of sulphides between the crust and the central, metallic core.

It would thus appear that the Earth, as a whole, is mainly composed, to the extent of over 98 per cent, of only seven elements. These seven, in their order of abundance, are: iron, oxygen, silicon, magnesium, nickel, calcium, and aluminum. Smaller amounts of four others, sulphur, sodium, chromium and potassium, bring the percentage to 99.60. Most of the other 81 elements may, therefore, be regarded as "impurities," possibly produced, as Clarke has suggested, by some process of evolution. It is noteworthy, also, that the above elements, with hydrogen and cobalt, appear to be those most abundant in the Sun's atmosphere.[14]

It may be of interest to call attention to the resemblance in some respects between the progression of the chief elements in the Earth and that in the atmosphere of the Sun, as recently interpreted.[15] In the chart of the Sun's atmosphere given by St. John and Babcock ionized calcium lies highest up, followed below by a thick shell of

[11] G. TAMMANN. *Zur Analyse des Erdinnern.* Zeitschr. Anorg. Chem. 131: 96. 1923.

[12] V. M. GOLDSCHMIDT. *Der Stoffwechsel der Erde.* Vid.-selsk. Skrifter 1922: no. 11; *Geochemische Verteilungsgesetze der Elemente.* Vid.-selsk. Skrifter. 1923: no. 3.

[13] G. TAMMANN. *Zur. Analyse des Erdinnern.* Zeitschr. Anorg. Chem. 131: 96. 1923.

[14] Cf. C. G. ABOTT. *The Sun,* 91. 1911.

[15] ST. JOHN and BABCOCK, *Note on the pressure and currents in the Sun's atmosphere.* Proc. Nat. Acad. Sci. 10: 390. 1924.

hydrogen; below this by titanium (ionized), sodium, and calcium; and at the bottom of the solar atmosphere a thin shell of iron vapor, with lanthanum.[16]

Some interesting questions suggest themselves in connection with the distribution of the chief elements in the Earth: What is the origin of the relatively enormous mass of metallic nickel-iron? Was there originally sufficient silica to silicatize all the nickel-iron? Is it due to reduction of original silicate, and if so by what reducing agent? Is "gravitative adjustment" alone responsible for the stratification or do other factors come in? Has there been an actual progressive oxidation or silication, such as is indicated by Prior's studies on meteorites? To what extent downward does the surficial areal heterogeneity (shown by the continental masses and the ocean floors) extend, and what is the cause of these heterogeneities? But attempts to give even speculative answers to these and other questions must await another occasion.

SPECTROSCOPY.—*Regularities in the arc spectrum of columbium.*[1] W. F. MEGGERS, Bureau of Standards.

Last year, a note was published[2] on *Regularities in the arc spectrum of vanadium.* These regularities were discovered by means of certain properties of spectral lines in multiplet structures, such as constant wave-number differences, temperature classification, and intensity rules accompanying transitions of azimuthal and inner quantum numbers. In a second note[3] some of these structures were confirmed by data on the Zeeman effect for vanadium lines, and some new multiplets were given. These and additional results not yet published indicate that most, if not all, of the spectrum lines of neutral vanadium may be explained by combinations of terms belonging to systems whose maximum multiplicities are even, i.e., doublets, quartets and sextets.

Similar studies have been made with the arc spectrum of columbium which occupies a position directly under vanadium in the periodic system of the chemical elements. This spectrum was expected to possess structures like those found for vanadium, and as far as the

[16] The "AL" in the first column of the chart is presumably a misprint for "LA", according to the text on page 391.

[1] Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce.

[2] MEGGERS. This JOURNAL 13: 317. 1923.

[3] MEGGERS. This JOURNAL 14: 152. 1924.

analysis has been completed, this has been confirmed. It has been impossible, however, to make the analysis for columbium as complete as that for vanadium, chiefly on account of the lack of accurate and complete data on its spectrum. The arc spectrum of columbium was partially described by Exner and Haschek[4] in a table of 1770 wave-lengths from 2376 A to 7047 A. Four hundred lines (4638–7047 A) have been measured on the international scale of wave lengths and published by Eder and Valenta.[5] The precision of the published values of wave-lengths and intensities is, in general, not as high as desirable for the purpose of recognizing polyfold levels from their various combinations. No data on the absorption spectrum, nor of its spectra in furnaces at various temperatures, exist for this element, although investigations to supply these have been recently undertaken by Dr. King at the Mt. Wilson Observatory. A very excellent study of the magnetic resolution of the spectrum lines of columbium was made by Jack[6] who determined the patterns for nearly 800 lines. Unfortunately only about 100 of these have been published, and the result is that even many of these are of little avail in the absence of other aids in completing multiplets. Furthermore, according to the general rule that in any particular column of the periodic table, the separations of the polyfold levels are larger for the heavier elements, these separations are, in the mean, three to four times larger for columbium than for vanadium. The result is that the multiplets for the former, being spread over larger intervals, are more likely to overlap, and are consequently more difficult to disentangle than those for the latter. These considerations have led me to publish only a few of the columbium multiplets at the present time, and to postpone the remainder until they can be presented in full together with a new table of wave-lengths, intensities and other data which are now being collected.

The first regularities in the arc spectrum of columbium were discovered in the sextet system because the strongest lines belong to this system, the separations of the polyfold levels are smaller here than for the quartet-system terms, and also excellent values of the Zeeman effect have been published for some of the lines belonging to this sys-

[4] Spektren der Elemente bei normalem Druck, II, Deuticke, Wien. 1911.

[5] Sitzungsber, d.k. Akad, d. Wiss, Wien. 119 IIa: 559. 1910.

[6] Proc. Roy. Irish Acad. Dublin. 30 A: 42. 1912.

tem. Table 1 contains three multiplets which originate in term combinations of the type DP, DD′ and DF, respectively. Subscripts to the term symbols represent inner quantum numbers. Each one of the permitted combinations gives rise to a spectral line whose estimated intensity, wave-length in air, and corresponding wave number (number of waves per cm vacuo) are shown. The intensities and wave lengths (corrected to the international scale) are from Exner and Haschek, except for the line 4078.34 A which was measured on my plates.

TABLE 1.—MULTIPLETS IN THE ARC SPECTRUM OF COLUMBIUM (SEXTET SYSTEM)

	D_1	154.1	D_2	237.8	D_3	303.4	D_4	355.0	D_5
P_2	4 4116.91 24283.22		3 4143.22 24129.07		4 4184.44 23891.38				
259.7									
P_3			4 4099.10 24388.76		3 4139.43 24151.15		10 4192.07 23847.85		
361.6									
P_4					2 4078.34 24512.87		8 4129.45 24209.50		20 4190.93 23854.33
D_1	3 3765.07 26552.39		20 3787.11 26397.90						
161.0									
D_2	20 3742.45 26712.90		2 3764.09 26559.29		10 3798.14 26321.26				
269.8									
D_3			20 3726.25 26829.00		10 3759.58 26591.22		20 3802.98 26287.71		
443.8									
D_4					10 3697.85 27035.06		20 3739.85 26731.47		15 3790.15 26376.73
547.9									
D_5							8 3664.70 27279.62		20 3713.06 26924.35

TABLE 1—*Continued*

	D_1	154.1	D_2	237.8	D_3	303.4	D_4	355.0	D_5
F_1	20 4168.14 23984.78		8 4195.13 23830.46						
180.0									
F_2	15 4137.15 24164.45		20 4163.64 24010.70		20 4205.34 23772.62				
231.9									
F_3			20 4123.86 24242.30		15 4164.65 24004.87		20 4217.98 23701.40		
372.7									
F_4					30 4100.99 u 24377.52		20 4152.65 24074.22		15 4214.75 23719.56
430.0									
F_5							30 4079.73 u 24504.52		20 4139.74 24149.34
480.4									
F_6									50 4058.99 u 24629.76

TABLE 2.—ZEEMAN EFFECT FOR COLUMBIUM LINES

Terms	λ	*Obs.*	*Calc.*
P_2D_1	4116.91	(0.00) 0.00, 1.88	(0.47) 1.94 2.88
P_4D_4	4129.45	(0.40) 1.65	(*** 0.44) *** 1.66 ***
P_2D_2	4143.22	(0.80) 1.85	(0.27, 0.80) 1.60, 2.13, 2.66
P_3D_4	4192.07	(0.47) 1.22	(0.15, 0.45 *) 0.84, 1.14****
D_2F_3	4123.86	(0.32, 0.90) 0.47, 1.02, 1.58	(0.28, 0.83) 0.49, 1.04, 1.59, 2.15
D_1F_2	4137.15	(1.13) 0.00 2.20	(1.14) 0.06, 2.20
D_5F_5	4139.74	(0.45) 1.44	(*** 0.42, 0.55) **** 1.50 ****
D_4F_4	4152.65	(0.65) 1.45	(** 0.48, 0.67) *** 1.50 ***
D_2F_2	4163.64	(1.18) 0.66, 1.46, 2.24	(0.40, 1.20) 0.67, 1.47, 2.26
D_3F_3	4164.65	(0.80) 1.50	(* 0.52, 0.86) *1.14, 1.49, 1.83*
D_1F_1	4168.14	(1.99) 1.33	(2.00) 1.33
D_2F_1	4195.13	(1.27) 0.84	(1.27) 0.60, 3.13
D_3F_2	4205.34	(0.28, 0.89) 1.26, 2.00, 2.58	(0.30, 0.89) 0.77, 1.36, 1.95, 2.55

The Zeeman-effect data available for these lines are presented in table 2 together with the patterns calculated according to Landé[7] for the combinations of terms indicated in the first column. The magnetic resolutions are expressed in terms of the separation of a normal triplet as a unit, the parallel components, in parenthesis, being followed by the perpendicular components. The stronger components are distinguished by bold face type, but some of the weaker components of calculated patterns are represented by asterisks. With few exceptions the agreement between observed and calculated results definitely confirms the term combinations assigned to the spectral lines.

The D term with separations 154.1, 237.8, 303.4 and 355.0 wave-numbers, which is common to the multiplets in table 1, is the lowest level in the sextet system, and probably the lowest in the atom, although its exact position relative to other systems has not yet been determined. The most sensitive columbium lines for the purpose of chemical analysis, the *raies ultimes*,[8] occur in the DF combination where they are marked u. This is another instance of such lines arising from a combination of the lowest level in a system with the next higher level having one unit larger azimuthal quantum number, and this may be regarded as a general rule for *raies ultimes*. It seems to be generally true also that such lines permit one to identify the lowest orbit in the atom. A case which appeared to be an exception was mentioned[9] in connection with the arc *raies ultimes* of titanium which were identified as an F^5G^5 group although the low F^5 level is about 6500 wave-numbers higher than the lowest F^3 level. This case has been looked into again and it was found that the lines 3635.47, 3642.68, and 3653.49 A in an F^3G^3 group appear to be equally, if not more sensitive than 4981.73, 4991.06 A, etc., which result from the F^5G^5 combination. If the lines of the triplet system are really the most sensitive for titanium and if the *raies ultimes* always involve the lowest level in the atom it may be of interest to note that according to de Gramont's *raies ultimes* the lowest level in neutral zirconium is represented by an F^5 term, in neutral vanadium by an F^4 term but in columbium by a D^6 term.

[7] Zeitschr. f. Phys. **15**: 189. 1923.

[8] DE GRAMONT. Comptes Rendus **171**: 1106. 1920.

[9] MEGGERS, KIESS and WALTERS. J. O. S. A. & R. S. I. **9**: 355. 1924.

BOTANY.—*New or little known Melastomataceae from Venezuela and Panama. II.*[1] H. PITTIER.

Miconia gatunensis Pittier, n. sp. (Sect. *Tamonea*)

Arbuscula ubique glaberrima, ramis superne plus minusve acute tetragonis inferne teretibus laevibusque; foliis modice petiolatis, subcoriaceis, supra intense subtus laete viridibus, petiolo tereti supra sulcato, laminis ovalibus subobovalibusve tripli- vel subquintuplinerviis, nervis prominentibus, basi rotundatis subacutisve apice abrupte anguste acuminatis, acumine brevi subacuto, marginibus integerrimis, venis transversalibus distantibus utrinque conspicuis, subtus prominulis, parce ramulosis; paniculis terminalibus, basi trichotomis, ad nodos inferiores 4-8-ramulosis, ramulis gracilibus, bis trichotomis; floribus pentameris brevissime pedicellatis, calyce tubuloso-campanulato, limbo obscure sub-5-dentato, persistente, petalis lineari-oblongis, albis, apice inaequaliter bilobulatis interdum reflexis; staminibus satis inaequalibus, filamentis gracilibus, antheris elongatis, apice attenuatis, uniporosis, basi bilobulatis, lobulis glandulis minutissimis pedicellatis tectis; ovario 3-loculari, glabro, usque ad medium libero, stylo elongato, apice subcapitellato.

Arbuscula 2–3- metralis. Ramuli parce ramulosi, virescentes. Petiolus 1–3 cm. longus; laminae 9–20 cm. longae, 5–7.5 cm. latae, acumine 1–1.5 cm. longo; nervulis transversalibus suberectis, 6–8 mm. distantibus. Paniculae circa 10 cm. longae, laxe pyramidatae. Pedicelli usque ad 0.5 mm. longi. Calyx 4.5–4.7 mm. longus. Petala 4.5–5 mm. longa, 2–2.2 mm. lata. Filamenta 2–6 mm. longa; antherae 5–6 mm. longae. Ovarium 1.5 mm. longum; stylus usque ad 12.5 mm. longus. Bacca ignota.

PANAMA: Humid forest along Río Indio de Gatún, Canal Zone, fl. February 17, 1911, *H. Pittier* 2786 (type).

This species seems to be nearly related to *Miconia subnodosa* Triana, but differs from it in its rather obtuse and terete branchlets, in the shape and dimensions of the leaves, and in the size of the flowers, in which the stamens are manifestly glandulous on the basal lobes.

Miconia septuplinervis Pittier, n. sp. (Sect. *Eumiconia-Aplostachyae*)

Frutex ramulis junioribus cinereis, vix compressis, petiolis pedunculisque dense adpresse hirsutis; foliis breve petiolatis, insigniter 7-plinerviis, petiolo brevi, canaliculato, laminis elliptico-lanceolatis, basi acutatis, apice sensim acuminatis, margine subintegris, ciliatis, supra viridibus parce adpresse hirsutis, nervis supra subtusque dense hirsutis; spicis majusculis, terminalibus, regulariter interruptis; floribus 3–4-glomerulatis, sessilibus, glomerulis oppositis; calyce urceolato, 5-dentato, dense adpresse hirsuto; petalis 5, ovalibus, reflexis, glabris, apice rotundatis; staminibus 10, glabris, filamentis antherae aequantibus, connectivo vix producto. Ovarium 3-loculare; stylus glaber; stigma punctiforme papillosum.

Frutex 2–3 metralis, parce ramosus. Folia in eodem jugo inaequalia; petiolus basi crassus, 6–10 mm. longus; lamina 12–27 cm. longa, 5–11 cm. lata, nervo mediano crassiore, lateralibus margini valde approximatis. Spicae erectae, validae, 12–18 cm. longae, pedunculo anguloso; glomeruli 1.5–2 cm. distantes. Calyx ecostatus, 3.5–4 mm. longus, apice 3.2 mm. latus.

[1] The first of these contributions was published in This JOURNAL 13: 384–392. 1923.

Petala alba, enervia, 2.5 mm. longa, 1.5 mm. lata. Staminum filamenta gracilia, 2.5–3 mm. longa; antherae lineares e basi leviter attenuatae, 0.6 mm. crassae. Stylus circa 4 mm. longus.

PANAMA: Forests around San Felix, Chiriquí, fl. December 17, 1911, *Pittier* 5175 (type).

This striking species of the subsection *Eumiconia-Aplostachyae* is, so far as I know, the only one in the group with leaves genuinely multiplinerved. In several of the known species, the leaves are said to be trinerved, or almost triplinerved; in a few others they are triplinerved; but in our specimens they are distinctly septuplinerved, the three pairs of opposite nerves showing in light gray on the upper face of the leaf, and being made more conspicuous on the lower face by a neat fringe of gray. h hairs. Furthermore, these leaves are larger than in any other species of the group, and the spikes are surpassed in length only in *M. longipedunculata* and *M. longispicata.* The flowers, forming regularly distant clusters in which one of them opens at a time, seem to differ also by their superior dimensions.

With the exception of *M. triplinervis* R. & P., reported once from Mexico, *M. septuplinervis* seems to be only species of the *Aplostachyae* found north of the Isthmus of Panama.

Miconia caudiculata Pittier, n. sp. (Sect. *Glossocentrum*)

Arbuscula ramulis acute tetragonis, superne valde compressis, junioribus petiolis pedunculisque dense squamuloso-furfurescentibus; foliis oppositis, membranaceis, breviter petiolatis, nervulo marginali praetermisso 3-plinerviis, petiolo subtus striato supra late canaliculato, laminis oblongo-lanceolatis basi sensim attenuatis et in petiolo decurrentibus, apice angustato in caudiculam tenuissimam squamosulam abrupte contracto, marginibus integris plusminusve revolutis, supra glaberrimis in sicco nigrescentibus, subtus tenuiter stellato-tomentellis pallide viridibus; nervis supra immersis, subtus eleganter prominentibus; paniculis terminalibus, ramosis, folia subaequantibus, ramulis decussatis, subsimplicibus, multifloris; floribus 5-meris, subsessilibus, basi bracteolis minimis subpersistentibus suffultis; calyce globoso subcampanulato, apice vix sinuato, extus squamulis stellato-ciliatis cinereis utrinque tecto; petalis albis, obovatis, oblique retusis, reflexis, glabris; staminibus 10, inaequalibus, saepius reflexis, filamentis glabris, compressis, antheris truncatis late uniporosis connectivo infra loculos modice producto, breviter calcarato, cum filamento geniculato; ovario 3-loculari superne glabro; bacca globoso-depressa, caeruleo-nigrescente, edule.

Arbuscula ad 4 m. alta. Petiolus 1–1.5 cm. longus; laminae 12–20 cm. longae, 3.5–6 cm. latae; caudicula apicalis 4–9 mm. longa. Racemi 15–22 cm. longi, circa 6 cm. diam. Pedicelli 0.1–0.2 mm. longi. Calyx 2.6–2.8 mm. longus, 1.8–2 mm. diam. Petala 2.8–3 mm. longa, 1.7–2.1 mm. lata. Antherae cum connectivo 0.5 mm. producto circa 3 mm. longae. Stylus 6–7 mm. longus. Bacca 6–7 mm. diam., 5 mm. longa.

VENEZUELA: Zulia: Shady banks of the Sta. Ana and Lora rivers, sometimes in close formation, fl. and fr. December 1922, *Pittier* 10955, 10980 (last number the type).

This shrub, which is characteristic of certain shaded strips along the banks of the rivers in the Perijá district of Zulia, belongs to section *Glos-*

socentrum, represented so far in Venezuela only by *Miconia minutiflora* DC. It is likely, however, that besides this latter species and the newly described one, we have also in our territory *M. trichotoma* and *M. longifolia* DC., reported from the island of Trinidad. But *M. minutiflora* and *M. longifolia* belong to the group of species with pentamerous flowers and glabrous leaves, and *M. trichotoma* has tetramerous flowers, so that our *M. caudiculata* is the only Venezuelan representative of the species the leaves of which show a stellate indument on their lower face, species which so far have been known to occur only in Central and South Brazil. The new species should probably be placed close to *M. willdenowii* (Klotzsch) Cogn., from which it is easily distinguished by several characters, without mentioning the striking apical appendage of its leaves, which does not seem to have been noticed in any other species of the genus.

Miconia cuspidatissima Pittier, n. sp. (Sect. *Cremanium*)

Arbuscula ramis teretibus, flexuosis, glabrescentibus, ramulis novellis, petiolis, paniculis, calycibusque pilis plumoso-penicillatis stellulatisve fulvescentibus dense obtectis; foliis modice petiolatis, chartaceis, subconcoloribus; petiolo tereti; laminis ovato-oblongis, 3- vel sub-5-nerviis, margine integerrimis, basi late rotundatis vel interdum leviter emarginatis, apice longe angustissime cuspidatis, supra fere glabris, nervis impressis, subtus praecipue ad nervos venasque prominentes pilis plumoso-penicillatis tectis; paniculis laxis, basi dichotomis; ramulis floribusque trichotomis; pedicellis longis, gracilibus, basi bracteolis subulatis caducis suffultis; calyce late rotundo-campanulato, basi leviter costato, apice duplo 5-dentato, dentibus interioribus scariosis, late acutis, inconspicuis, exterioribus validioribus, conicis; petalis 5, suborbiculatis, vix unguiculatis, apice leviter emarginatis, in sicco luteis; staminibus 10, aequalibus, filamentis glabris, apicem versus attenuatis, antheris filamento duplo brevioribus, biporosis, obcuneatis, connectivo crasso, prominenti, basi bigibboso; ovario calyci adnato, triloculari, stylo glabro apice subclavato vel subcapitellato.

Arbuscula 3–4 m. alta. Petioli 1.5–2.5 cm. longi; laminae (cum cuspide 2–2.5 cm. longa) 10–15 cm. longae, 3.5–6 cm. latae. Panicula circa 10 cm. longa, pedunculo 2.4 cm. suffulta. Pedicelli 2.5 mm. longi. Bracteolae 1.5 mm. longae. Calyx 3 mm. longus latusque, dentibus exterioribus usque ad 0.5 mm. longis. Petala 2.5 mm. longa, 2.3 mm. lata. Stamina glaberrima, filamentis 3.3 mm., antheris 1.6–1.8 mm. longis. Ovarium 1.5 mm. altus; stylus 6.5 mm. longus.

PANAMA: Humid forest on the precipitous slopes between Alto de las Palmas and top of Cerro de la Horqueta, 2100–2268 m., Chiriquí, fl. March 18, 1911, *Pittier* 3224 (type).

This species should be placed either near *Miconia elata* DC., if the leaves are considered as 5-nerved, or if these are 3-nerved, near *M. rigens* Naud., the first a Jamaican, the latter a Colombian plant. The relation, however, seems to be remote, our plant being characterized by the long drip-point of its leaves, by the fulvescent indument formed of long plumose-penicillate hairs on the branchlets, leaves, and rachis of the inflorescence and of stellate hairs on the pedicels and calyx, by the double calyx teeth, etc. This latter character is unusual in Sect. *Cremanium*.

Miconia jahnii Pittier, n. sp. (Sect. *Cremanium*)

Arbuscula ramis tetragonis apice valde compressis ad nodos incrassatis, petiolis pedunculis ramulisque inflorescentiarum dense brununeo-furfurescentibus; foliis approximatis imis longe petiolatis; petiolis angulosis compressis; laminis ovato-lanceolatis basi subrotundatis, leviter attenuatis, apice sensim breviterque acuminatis, margine remote calloso-denticulatis, nervis lateralibus margini approximatis, supra glabris glabrescentibusve, in sicco nigrescentibus, nervis impressis, subtus fulvescente stellato-velutinis, nervis nervulisque prominentibus; inflorescentiis terminalibus paniculatis ovoideo-pyramidatis; floribus sessilibus subsessilibusque, in verticillis densis, approximatis, congestis; calyce urceolato, densiuscule furfuraceo, 5-dentato, dentibus brevibus acutis; petalis late obovatis, albis, patulis, margine irregulariter sinuatis; staminibus 10, glabris, antheris filamento dimidio brevioribus; stylo glabro, apice subclavato.

Arbuscula 2–3 m. alta. Internodii ramulorum foliatorum circa 1.5 cm. longi, defoliatorum 6–8 cm. Petioli 1–2 cm. longi; laminae 7–10 cm. longae, 2.5–4 cm. latae. Paniculae 6–10 cm. longae. Calyx 2–2.5 mm. longus, 2.4 mm. latus, dentibus circa 0.6 mm. longis. Petala 2–2.2 mm. longa, 1.7–2 mm. lata. Staminorum filamenta 2–2.5 mm. longa; antherae cuneatae, truncatae, biporosae, 1.7–1.9 mm. longae. Stylus 3–3.5 mm. longus.

VENEZUELA: Páramo Quirorá, 3000 m., Andes of Mérida, fl. January 24, 1922, *Jahn* 876 (type).

This species is nearly related to *Miconia granulosa* Naud., reported from the Eastern and Central Andes of Colombia and from Bolivia. It differs mainly in its smaller leaves, shorter panicles, and larger flowers. It grows on the margin of the high andine páramos.

Conostegia excelsa Pittier, n. sp.

Arbor pro genere excelsa, trunco erecto, coma elongata, sparsa, ramulis haud compressis, petiolis, laminis subtus atque inflorescentiis plus minusve dense furfuraceis; foliis longe petiolatis, 5-nerviis, coriaceis, integerrimis, petiolo evanescente furfuraceo, anguloso, laminis ovatis subobovatisve, basi obtuse rotundatis, apice late obtusis supra nervies interdum furfuraceis exceptis glaberrimis, nervis venisque transversalibus impressis, subtus nervis dorso interdum denudatis exceptis dense canescente furfuraceis, nervis venis venulisque prominentibus; paniculis brevibus, latis; floribus graciliter pedicellatis invisis; pedicellis leviter furfuraceis; bacca 5-loculari, basi stellato-furfurascente excepta glaberrima, semiglobosa; seminibus clavatis, apice truncatis, laevibus.

Arbor 20–25 m. alta. Petioli 2.5–6 cm. longi; laminae 7.5–17 cm. longae, 6–10.5 cm. latae. Pedicelli 6–8 mm. longi; bacca 0.5 cm. longa, apice 8 mm. diam. Semina 1–1.2 mm. longa, apice 0.4 mm. lata.

PANAMA: Humid forest around Los Siguas Camp, southern slope of Cerro de la Horqueta, at about 1700 m., Chiriquí, fr. March 18, 1911, *Pittier* 3196 (type).

In the absence of the flowers, it is difficult to establish the relationship of this species. It may be allied to *C. macracantha* Triana, but differs in the large size of the tree, in the 5-nerved leaves and in the apparently 5-merous flowers.

Topobea micrantha Pittier, n. sp.

Arbuscula marginis foliorum ciliatis exceptis glaberrima, ramis gracilibus flexuosisque teretibus, ramulis apice tetragonis; foliis parvis, petiolatis, 3–5-nerviis in eodem jugo inaequalibus; petiolo longo, gracili, canaliculato; laminis late ovalibus suborbiculatisve basi acutissimis, apice abrupte breve acuminatis, margine leviter revolutis remote denticulatis ciliatisque, supra laete viridibus nervo medio prominulo, lateralibus subimpressis, subtus glaucescentibus nervis prominulis, supra subtusque densiuscule rufo-punctulatis; inflorescentiis axillaribus, brevibus, pedunculatis, trichotomis, copiose bracteolatis; pedunculo brevi, basi ebracteato; bracteolis oppositis, decussatis, spathulato-oblongis, basi longe attenuatis, apice obtusis, margine crenato-denticulatis, interdum ciliatis, trinerviis, plus minusve punctulatis, quam flores longioribus; floribus parvis, 5-meris, pedicellatis; pedicellis brevibus; calyce tubuloso-campanulato, leviter 10-costato, limbo 5-lobulato, lobulis late rotundatis, scariosis, extus dentibus validis subaequilongis productis; petalis 5, orbiculatis, albo-roseis, vix unguiculatis, apice levissime emarginatis; staminibus 10; ovario 4-loculari; bacca sicca, moriformi, calycis lobulis persistentibus coronata; seminibus paucis, obovato-cuneatis, punctulatis.

Arbuscula 1–3 m. alta. Petiolus 0.8–1.8 cm. longus; laminae 3–5 cm. longae, 1.5–2.8 cm. latae. Inflorescentiae 1–1.5 cm. longae; pedunculus 0.4–0.5 cm. longus. Pedicelli 0.5–1.5 mm. longi. Bracteolae 5–7 mm. longae, 1.5–1.8 mm. latae. Calyx 2.5 mm. longus (tubus 1.7 mm., lobulis 0.8 mm.), apice tubi 1.8 mm. latus. Petala 2.5 mm. longa lataque; et caeterae ignotae.

PANAMA: Humid forests on the precipitous western slope of Cerro de la Horqueta, 2100–2268 m., Chiriquí, fl. and fr. March 18, 1911, *Pittier* 3276 (type).

It is not without hesitation that this remarkable plant is placed in genus *Topobea.* It agrees with this, it is true, in the general characters of the flower, fruit, and seeds, but the flowers and leaves are very small as compared with those of the other species of the genus, and the imperfect stamens at my disposal also seem to be different in their structure. In the bud, however, they are disposed in the same way as in *Blakea* and *Topobea*, the anthers being bent down inward so that their tips occupy the hollow at the apex of the ovary, around the style. The bracts, longer than the flowers, are not imbricate, but somewhat distant and decussate. Other striking characters are the ciliate leaves (noted also in *T. ciliata* from Ecuador), and the numerous brown dots on the leaves, which, on closer observation are found to be formed by dense groups of diminute squamose hairs. Identical dots are seen on the leaves of *T. punctulata* and *T. latifolia*, from Colombia, as well as on those of *T. superba* and *T. regeliana*, both of which grow within the limits of Panama, but are not at all closely related to our plant.

BOTANY.—*Five new plants from Venezuela.* S. F. BLAKE, Bureau of Plant Industry.

Four of the new species described in this paper are from high altitudes in the Andes of the States of Trujillo and Mérida, Venezuela. One is a striking *Draba*, with stout stem, fleshy leaves, and large yellow flowers; one is a species of *Aragoa*, a genus of shrubs allied to *Veronica*, and previously known only from Colombia; one is an alpine *Erigeron*, allied to *E. nevadensis* Wedd.; and the fourth is a species of *Desmanthodium*, a small genus of the *Heliantheae-Millerinae*, hitherto found only in Mexico and Guatemala. The fifth plant belongs to *Riencourtia*, and is the second new species of that genus collected in Venezuela by Mr. Henry Pittier.

Draba bellardii Blake, sp. nov. Caudex thick, with few short branches; stem low, thick, stellate-pubescent; basal leaves tufted, fleshy, yellowish green, oblong, serrate above, ciliate; stem leaves similar but shorter and broader; inflorescence dense; pedicels 1 cm. long or less; petals yellow, 7.5–10 mm. long; ovary glabrous, the ovules about 20 in each cell; style and stigma 2 mm. long.

Herbaceous perennial, about 14 cm. high; caudex thick, 4-branched, the branches short, erect, densely clothed toward apex with the imbricated corky bases of fallen leaves, one bearing a flowering stem, the others dense tufts of leaves; basal leaves tufted, fleshy, yellowish-green, sessile, narrowly oblong or oblanceolate-oblong, 4 to 5 cm. long, about 1.2 cm. wide, acute, serrate above the middle (teeth about 4 pairs, acute or acutish), hirsute-ciliate below the middle and denticulate-hirsute-ciliate above, the broad yellowish-white costa antrorse-hirsutulous with simple hairs on upper surface of leaf, glabrous beneath like the whole under surface; flowering stem leafy, stout (nearly 1 cm. thick), angled and striate, yellowish green, evenly but not densely stellate-pubescent with spreading, 2- or 3-branched hairs; stem leaves similar to the basal but rather shorter and broader, with slightly clasping base, the upper ones (subtending the lower branches of the inflorescence) ovate, about 2.5 cm. long, 1.5 cm. wide, pubescent like the basal leaves, about 7-toothed on each side above the entire base; inflorescence about 7 cm. long, dense, leafy-bracted, short-branched below, the flowers congested; pedicels in anthesis 1 cm. long or less, stout, pubescent like the stem; sepals oblong or obovate-oblong, 7 to 8 mm. long, 3.5 mm. wide, rounded, yellowish green, sparsely hirsute along midline with simple or bifurcate ascending hairs; petals yellow, equal, 7.5 to 10 mm. long, glabrous, the claw 2.5 to 4.5 mm. long, about 1.2 mm. wide, the blade suborbicular, subtruncate, 5 to 5.5 mm. long, 5.5 to 6.5 mm. wide, about 8-nerved; stamens 6, free, equal, the stout subulate filaments 5.5 to 6 mm. long; ovary ellipsoid, glabrous, 5 mm. long, the ovules pendulous on slender funicles, in two rows of about 10 each in each cell; style and stigma 2 mm. long, the style cylindric-conic, the stigma slightly bilobed.

VENEZUELA: At the perpetual snow line, Sierra de Mucubajá, Andes of Mérida, altitude 4,880 meters, 1922, *E. P. de Bellard* 14 (type no. 1,185,120, U. S. Nat. Herb.).

Remarkable for its very stout leafy stem and large yellow flowers. The species evidently belongs in the section *Volcanicae* of Gilg, and is nearest the Colombian *Draba pachythyrsa* Triana & Planch., which is described as having lanceolate few-dentate leaves, contracted into a short broad petiole, violascent calyx, a very short style, and about 6-seeded capsule cells.

Aragoa lucidula Blake, sp. nov. Branches pilose-lanate; leaves oblong, 2–2.8 mm. long, obtuse, appressed, not keeled, shining, pubescent on back and margin; flowers sessile, small; calyx pubescent; corolla pilose at base of tube.

Shrub; branches and branchlets numerous, mostly opposite or in 3's, the branchlets 1.5–2 mm. thick (including the leaves), terete, cinereously pilose-lanate, densely covered by the appressed, crowded, long-persistent, many-ranked leaves; leaves of main stem linear-oblong, 2.8 mm. long, about 0.5 mm. wide, obtuse, concave inside, sparsely pilosulous dorsally, those of branches and branchlets oblong, 2–2.6 mm. long, 0.8 mm. wide, obtuse, thick, concave and glabrous inside, rounded and loosely pilose on back, ciliate especially toward apex, dark green and shining, with narrow pale margin; flowers few toward apex of branches, sessile; calyx 5-parted, 2–2.8 mm. long, the segments imbricated, oval, rounded, 1.5 mm. wide, subcoriaceous, with green center and subequal subscarious margins, pilose on the green portion of back, especially toward apex, and ciliate; corolla campanulate-rotate, 4-lobed about to middle, 7 mm. wide, long-pilose in a ring at base inside, otherwise glabrous, the campanulate tube 2 mm. long, the obovate-oblong rounded entire lobes 3 mm. long; stamens 4, the filaments flattish-subulate, 3 mm. long, pilose about to middle, adherent to tube throughout its length, the anthers reniform, confluently 1-celled; disk annular, thick; ovary globose-ovoid, glabrous, shorter than style, 2-celled, several-ovuled; capsule ovoid, glabrous, 2 mm. long, 4-valved, the valves thick, the septum free; seeds (immature?) obscurely winged.

VENEZUELA: Sierra Nevada de Santo Domingo, Mérida, altitude 3600 meters, 12 Sept. 1922, *A. Jahn* 1091 (type no. 1,186,693, U. S. Nat. Herb.).

Aragoa lucidula is the first species of the genus to be found in Venezuela. From the three species of the genus previously known, all of which are Colombian, it is distinguished by its small flowers and dorsally pubescent leaves. The vernacular names given by Dr. Jahn are "romero negro" and "chicote," the former signifying "black rosemary," the latter ("end of a rope," Velázquez Dictionary) presumably referring to the ropelike appearance of the branches. The name "romero de páramo" is given on a sheet of *A. cupressina* H. B. K. in the National Herbarium, collected by Triana near Bogotá.

Erigeron blepharophyllus Blake, sp. nov. Perennial, with short and thick rhizome; leaves all in a basal tuft, narrowly cuneate or oblanceolate, about 5 cm. long, narrowed to the sessile base, denticulate toward apex, densely pilose and stipitate-glandular; stem scapiform, 1-headed; involucre subequal, glandular-pilose; rays numerous, about half longer than the involucre; achenes hispid.

Rhizome erectish, about 1.5 cm. long, simple; basal leaves 12 or more, 4.5–6 cm. long, 4–8 mm. wide, erect or in age reflexed, acute or obtuse and

somewhat callous-thickened at apex, gradually narrowed to base, about 4-denticulate on each side toward apex with small blunt callous teeth, 1-nerved or with a pair of lateral nerves well above the base (the nerves all impressed), densely pilose with many-celled acuminate hairs on both sides and on margin and also stipitate-glandular, thick-herbaceous (perhaps fleshy in life), subscarious and glabrous within toward the base, this about 5-nerved; stems one or two, erect, 12–22 cm. high, densely pubescent with dark several-celled gland-tipped hairs and sparsely pilose, bearing 2–4 linear bracts, these 3–13 mm. long, 0.5–2 mm. wide, pubescent like the basal leaves; head 2 cm. wide; disk 7–8 mm. high, 12 mm. thick; involucre about 2-seriate, 8–9 mm. high, the phyllaries linear (1 mm. wide), acuminate, erect, the outer dull green or purplish, stipitate-glandular and pilose, with very narrow or obsolete scarious margin, the inner whitish, indurate, with narrow scarious margin, 1-vittate, ciliate chiefly toward apex, otherwise nearly or quite glabrous; rays about 40, sub-2-seriate, whitish (when dried), considerably exceeding the involucre, the tube 2 mm. long, erect-pilose with several-celled hairs, the lamina linear-elliptic, bidenticulate, 4-nerved, 6 mm. long, 1.7 mm. wide; disk corollas apparently whitish, erect-pilose with several-celled hairs at base of throat and sparsely so on teeth, 4 or 5-toothed, 4.3 mm. long (tube 1.8 mm., throat funnelform, 1.3 mm., teeth ovate, obtuse or acute, 1.2 mm. long); achenes (immature) of ray and disk slender, hispid, several-nerved, 2.5 mm. long; pappus of 25–30 hispidulous rufid bristles 4 mm. long, a few of the outer only about half as long; anthers sagittate at base; style branches with lanceolate, acute, finely papillose-hispidulous appendages.

VENEZUELA: Páramo del Jabón, Trujillo, altitude 3300 m., 2 Oct. 1910, *Alfredo Jahn* 46 (type no. 602241, U. S. Nat. Herb.); Páramo de Aricagua, Mérida, altitude 3300 meters, 31 March 1922, *Jahn* 1035.

Allied to *Erigeron nevadensis* Wedd., which is similar in appearance but is not glandular, and has merely ciliolate leaves with glabrous faces.

Desmanthodium blepharopodum Blake, sp. nov. Stem essentially glabrous; leaves ovate, denticulate, subcoriaceous, practically glabrous, on rather short densely ciliate petioles; heads medium-sized for the genus, 6–10-flowered.

Stem herbaceous above, rather stout, subterete, hirsutulous chiefly in 2 lines with mostly appressed, several-celled hairs, quickly glabrate; leaves opposite; petioles unmargined, connate at base, densely ciliate with several-celled sordid hairs, 3–13 mm. long; blades ovate, 7–17 cm. long, 3.5–7 cm. wide, acuminate, at base cuneate, remotely denticulate (teeth about 0.5 mm. high, 5–8 mm. apart), subcoriaceous, hirsute-ciliate when young, above deep dull green, very sparsely hirsutulous, beneath slightly lighter green, very sparsely hirsutulous along some of the veins or essentially glabrous, quintuplinerved well above the base, the nerves impressed above, with the secondaries loosely prominulous-reticulate beneath; panicle trichotomous, flattish-topped, 14 cm. wide, its branches sordid-hirsutulous in lines with spreading or ascending hairs, the branchlets strongly flattened, hirsutulous on the upper side, the bracts (except the lowest pair) 1 cm. long or less, ovate, coriaceous; heads sessile, about 5 mm. high, 3 mm. thick, 6–10-flowered, crowded at tips of branchlets in glomerules about 1 cm. thick; outer phyllaries 4, the outermost one suborbicular, about 10-nerved, the others smaller, oblong or obovate, all whitish, subscarious, rounded, glabrous;

♀ flowers 3, inclosed in bottle-shaped, strongly obcompressed, obliquely truncate, few-nerved, glabrous, whitish phyllaries 3.5–4.5 mm. long and 2 mm. wide, their corollas whitish, tubular-funnelform, glabrous, 1.5 mm. long, the limb irregularly about 6-toothed; disk flowers (sterile) 3–7, their corollas whitish, 2–3 mm. long, hirsute above, with subcylindric tube, short campanulate throat, and 5 erect teeth longer than the tube and throat; receptacular pales none; achene obcompressed-trigonous, obovoid, glabrous, blackish, 2.8 mm. long, 1 mm. wide, crowned with a fleshy ring; sterile ovaries oblong to linear, 1–3 mm. long, hirsutulous with 1-celled hairs.

VENEZUELA: Between La Puerta and Timotes, States of Trujillo and Mérida, altitude 2000 meters, 16 Sept. 1922, *Alfredo Jahn* 1143 (type no. 1,186,743, U. S. Nat. Herb.).

Nearest *Desmanthodium guatemalense* Hemsl., which has glaucescent branches and thin-membranous, more or less rhombic-ovate, subsessile leaves which are not ciliate at the base. No species of the genus has hitherto been known outside of Mexico and Guatemala, the Colombian plant described as *Desmanthodium trianae* Hieron. being really a typical *Clibadium* (*C. trianae* (Hierón.) Blake, Contr. Gray Herb. n. ser. **52**: 6. 1917).

Riencourtia pittieri Blake, sp. nov. Stem strigose; leaves mostly ovate or elliptic-ovate, 3.5–4.8 cm. long, 1.5–1.7 cm. wide, hirsute and hispidulous; heads in few glomerules, 9-flowered.

Erect herb, about 55 cm. high, the base not seen; stem slender, with short erectish branches, evenly but not densely strigose with tuberculate-based hairs; internodes 6 to 12.5 cm. long, much surpassing the leaves; leaves opposite, those of the main stem about 7 pairs; petioles hispid-strigose, 2 to 3 mm. long; blades of the lowest leaves oval-ovate, about 2 cm. long, 1 cm. wide, obtuse, those of the middle and upper ovate or elliptic-ovate, 3.5 to 4.8 cm. long, 1.5 to 1.7 cm. wide, acute or acutish, rounded at base, serrate (teeth about 9 pairs, depressed-triangular, mucronulate), above deep dull green, hispid and hispidulous with tuberculate-based mostly incurved hairs, beneath lighter green, hispid-hirsute and hispidulous along all the veins and veinlets with spreading or divergent hairs, triplinerved from near the base (the lateral nerves with a basal branch) and prominulous-reticulate beneath, impressed-veined above; peduncles solitary at tips of branches, ternate at apex of stem, 4 to 5.5 cm. long, strigose; glomerules about 1 cm. wide and high, subtended by a pair of reflexed lanceolate bracts about 12 mm. long; heads (excluding corollas) 5 mm. high, 3 mm. wide, compressed, 9-flowered; phyllaries 4, dry, whitish, hispid above, mucronulate, the two outer folded, 4.2 mm. long, the two inner flattish, 5 mm. long; ♀ flower 1, the corolla not seen; disk flowers (sterile) 8, their corollas yellowish-white, 3 mm. long (tube slender, 1 mm., throat campanulate, 1 mm., teeth 5, ovate, 1 mm. long), the teeth hispid-hirsute with spreading hairs above on back, inside densely barbatulate and with a tuft of longer hairs at apex; achene obovoid, plump, pilose, margined, 3.2 mm. long, 2.2 mm. wide; sterile ovaries linear, pilose, 4 mm. long or less.

VENEZUELA: In savannas, Upper Cotiza, near Caracas, altitude 1250 meters, 18 Sept. 1921, *Pittier* 9824 (type no. 1,122,830, U. S. Nat. Herb.).

This plant is nearest the Brazilian *Riencourtia latifolia* Gardn., with which it agrees in most characters. No material of *R. latifolia* has been examined, but Dr. A. B. Rendle and Mr. John Hutchinson, who have examined the

material of the type collection (*Gardner* 3280) in the British Museum and the Kew Herbarium, inform me that the stem-pubescence is wide-spreading in that species, while it is closely appressed in *R. pittieri*. *Riencourtia pittieri* is the second species of the genus known from Venezuela, the other being *R. ovata* Blake, recently described from specimens collected by Mr. Pittier in savannas near Valencia, State of Carabobo.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY

668TH MEETING

The 668th meeting was held in the lecture hall of the Cosmos Club, May 10, 1924, at 8 p.m. with Vice-President GOLDMAN in the chair and 36 persons present. New members elected: IRVING L. TOWERS, MURRAY T. DONOHO.

Under *Short Notes*, C. P. HARTLEY demonstrated that length of day was the factor limiting the amount of growth of stalk in the smaller varieties of corn. Specimens exhibited showed conclusively that in the same variety the stalk of an April planting was decidedly shorter than a stalk planted in June, though the two had grown in adjacent rows only four feet apart. In larger varieties conditions were equalized because of the longer growth period.

I. N. HOFFMAN exhibited and commented upon several of the largest known species of Coleoptera, belonging to the family *Lucanidae*.

In continuation of discussion of Mr. Hartley's note A. A. DOOLITTLE reported that corn planted for classroom study in October made a very short stalk. Mr HARTLEY considered this as probably due to the shortness of winter days.

E. A. GOLDMAN called attention to a belief prevalent in many places in the Tropics that timber cut in certain phases of the moon produces lumber more resistant to rot and insect infestation.

J. M. ALDRICH reported that one of the beetles exhibited by Mr. HOFFMAN, *Dynastes tityus*, frequently may be identified by its peculiar odor, even when the insect iself is not seen. He also stated that it was expected that Professor MARIO BEZZI, an Italian entomologist and a student of Diptera of high reputation, would come to this country to examine our National Park System for his government, and in addition under a grant from the National Research Council, to study insect life at high altitudes.

E. D. BALL: *Migratory habits of insects in arid regions* (Illustrated by slides). Migration is an adaptation that enables species to occupy regions which would otherwise be uninhabitable. Migratory habits in birds are well recognized phenomena. There are also many curious and interesting cases in insects. The milkweed butterfly each fall gathers in great swarms and flies southward from the Great Lakes and Manitoba to the Gulf regions. The black witch, a large Noctuid, reverses this process and flys northward from Cuba, oftentimes reaching the northern states, occasionally as far as Saskatchewan. Many other moths fly northward annually from southern regions. The migratory locusts of the Bible and similar species in South America, South Africa, and eastern Russia, in the course of their migrations cause great damage. In former times the buffalo came down in winter out of the mountain regions to sheltered spots on the plains. Lady beetles

reverse this process and fly to the exposed tops of mountains, where they gather in large swarms for hibernating purposes. Beet leafhoppers fly from the deserts to the beet fields in the irrigated valleys of the west. In the examples mentioned the migratory habit affects all individuals of the species alike and they all migrate at a stated time.

There is another type of migration in which only certain specially modified individuals take part. Many modifications of this kind are found in the arid regions of the western country. Most of the leafhoppers that feed on the short grasses have abbreviated wings, an adaptation which enables them to move about freely in these tangles. The areas they inhabit are subject to periodic droughts in which animal life, including even the insects, may be destroyed. These insects have a special migratory form with slender body and long wings that is capable of flying long distances. These migratory forms always appear very early in the season from the first nymphs that mature. Within a few days of emergence they fly away to other regions and thus distribute the species, leaving only the normal short-winged forms in the original location.

The Rocky Mountain Locust which was so destructive in the western regions from 1872 to 1876, was considered to be a distinct migratory species of grasshopper (*Melanoplus spretus*). Studies made during the recent outbreak have shown that this grasshopper is not a true species but only a specially modified long-winged migratory form of the common injurious grasshopper of the northern part of the United States (*Melanoplus atlantis*). Production of excessive numbers of the migratory form is probably correlated with periodic droughts. It is probable that migratory forms are present in many species in which they have not as yet been recognized. (*Author's abstract.*)

Discussion by J. M. ALDRICH, C. W. STILES, M. B. WAITE, E. A. GOLDMAN, and A. S. HITCHCOCK.

A. WETMORE, *Secretary, pro tem.*

SCIENTIFIC NOTES AND NEWS

Professor W. L. CORBIN, formerly of Boston University, has been appointed Librarian of the Smithsonian Institution. He succeeds PAUL BROCKETT who is at present Assistant Secretary of the National Academy of Sciences.

MRS. AGNES CHASE, assistant agrostologist of the Department of Agriculture, sailed for Rio de Janeiro October 18. She will remain about six months in Brazil studying and collecting grasses.

NEIL HOTCHKISS, a graduate of Syracuse University, has been appointed assistant in agrostology (junior botanist), Bureau of Plant Industry.

Dr. W. A. Orton has resigned as Pathologist in charge of the office of cotton, truck, and forage crop disease investigations in the Bureau of Plant Industry, to become scientific director and general manager of the Tropical Plant Research Foundation.

Dr. Orton entered the service of the Department of Agriculture in 1899, and has been prominently associated with its activities for slightly more than twenty-five years. In recognition of his long service an informal farewell dinner was given at the City Club, November 13, by his associates.

The Pick and Hammer Club held its first autumn meeting at the Geological Survey on October 25. Program: TAYLOR THOM, *The International Petroleum Congress at Tulsa;* FRANK HESS, *Chasing rare minerals;* DAVID WHITE, *The British Association meeting.*

NEIL M. JUDD, Curator of American Archeology, United States National Museum, returned to Washington September 30th. Mr. Judd has been engaged for four months in continuation of the National Geographic Society's explorations at Pueblo Bonito, Chaco Canyon National Monument, New Mexico. The past season's investigations constituted the fourth year of field work of the five year project previously noted in the Journal. Besides a noteworthy collection additional data bearing on prehistoric peoples of the Southwest were gathered. It is felt that the 1924 explorations have proven the most profitable of the series.

Two courses of lectures are being given at the National Museum at 4.30 p.m. Fridays and Mondays by DR. ALEŠ HRDLIČKA. The first, which commenced on October 24 and is given on Fridays, is entitled *Man's origin,* and includes: a. *Evolution in nature, its causes and objects;* b. *What is "man?" His relation to other living beings;* c. *Man's origin; the material evidence bearing on the subject;* d. *The why, where, when, and how of man's ascent;* e. *Man's spread and differentiation;* f. *The racial composition of existing nations;* g. *Man's present and future.* The second course, given on Mondays, entitled *Man's physical and physiological characteristics,* includes: a. *The life cycle of man; the developmental stage, growth, the adult stage, senility, death;* b. *The adult body, pigmentation, skin, eyes, and hair; stature, weight; the head, the face, rest of the body;* c. *The brain; organs of sense;* d. *The functions of the body;* e. *Mentality.*

NED HOLLISTER, Superintendent of the National Zoological Park since 1916, and one of the foremost mammologists of the world, died November 3, following an operation.

Mr. Hollister was born at Delavan, Wisconsin, November 26, 1876, where he received his education and began the study of zoology. From 1902 to 1909 he conducted zoological field work for the Biological Survey in the west. In 1910 he was appointed Assistant Curator of Mammals in the U. S. National Museum; this position he held until 1916 when he became Superintendent of the Zoological Park. In 1912 he represented the Smithsonian Institution on the Smithsonian-Harvard Expedition to the Altai Mountains, Siberia.

Mr. Hollister was the author of a number of important works on zoological subjects, including *The birds of Wisconsin* (1903), *Mammals of the Philippine Islands* (1911), *Mammals of the Alpine Club Expedition to Mount Robson* (1913), and *East African mammals in the U. S. National Museum* (1918, 1919, 1923). The last, probably Mr. Hollister's chief contribution to science, is a complete technical account of the East African collections made by Theodore Roosevelt, Paul Rainey, and others.

During Mr. Hollister's term of office as Superintendent, the National Zoological Park has shown steady growth and development. Many improvements to the grounds and animal quarters were carried out, and he made every effort to provide for the enjoyment and convenience of the public.

Mr. Hollister was a member of the ACADEMY and served as Associate Editor of this JOURNAL from 1919 to 1923, representing the Biological Society.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 14 DECEMBER 4, 1924 No. 20

GEOPHYSICS.—*Temperatures at moderate depths within the Earth.*[1] LEASON H. ADAMS. Geophysical Laboratory, Carnegie Institution of Washington.

In the application of the results of laboratory measurements to the solution of problems concerning the Earth's interior it is important to have an estimate, even though it be a very crude one, of the temperatures at various depths within the Earth. The possibility of the stable existence of certain minerals at great depths, the physical condition of the Earth's "crust," the mechanism of isostatic adjustments,—these are some of the questions requiring a knowledge not only of the physical constants of rocks but also of the temperatures and pressures far below the surface. The determination of the pressure is comparatively simple—for depths as great as several hundred kilometers the pressure can be calculated with an uncertainty of not more than 10 per cent—but the estimation of the temperature is attended by many difficulties and leads to less satisfactory results.

The direct measurement of temperature at any considerable depth is, of course, out of the question; the deepest bore-hole ever made (near Fairmont, West Virginia) is only 2.4 kilometers deep. Moreover, the direct extrapolation of the temperature gradient, measured in such bore-holes, to a depth several hundredfold that actually attained, is a task from which even the most optimistic speculator would shrink. The first important attack on this problem was made by Lord Kelvin in 1862. On the assumption that the Earth was originally molten, that it cooled rapidly by convection until the solidification-point was reached, and that cooling then proceeded by the much slower process of thermal diffusion, the problem becomes that of the cooling

[1] Received November 1, 1924.

of a sphere with constant surface temperature, and the temperature at any depth can be calculated in terms of the original temperature and of the time since solidification.[2] From the melting-point of ordinary rocks and from the surface temperature-gradient as measured in deep borings the age of the Earth, that is, the time which has elapsed since solidification, may be determined. But the age of the Earth estimated in this way is only 40 to 100 million years (depending on the assumed initial conditions), and so short a time has been held not to accord with geologic evidence.

The Kelvin theory of the cooling of the Earth was therefore never received favorably by the geologists, and the temperatures at various depths as calculated from the Kelvin equation were not universally accepted. But no one was able to point out the fallacy in the theory until the discovery of radioactivity and of the widespread occurrence of radioactive elements in the rocks of the Earth's crust, which showed that the conduction of heat from the interior is not the only thermal effect to be considered, and that the heat produced by the spontaneous disintegration of radioactive elements is a factor of great importance. The investigations of Strutt[3] and of Joly[4] led to the astonishing result that if the average amount of radioactive material throughout the whole Earth were only a small fraction of that found in the surface rocks then the Earth is not cooling at all but would be getting continually hotter. It is evident that this discovery definitely removed the possibility of calculating the age of the Earth and the temperatures at great depths from the observed superficial temperature-gradient alone.

[2] *Cf.* THOMPSON and TAIT, *Treatise on natural philosophy*, II: 474. 1895. For depths of 1000 kilometers or less the formula is

$$\theta - \theta_f = (\theta_0 - \theta_f) \operatorname{Erf} \frac{x}{2\,h\sqrt{t}}$$

in which θ is the temperature at any point, θ is the constant surface temperature, θ_0 is the initial temperature of the sphere, x is the depth below the surface, t is the time which has elapsed since solidification, h^2 is the thermal diffusivity of average rock (that is, $k/c\rho$, k being the thermal conductivity, c the specific heat, and ρ the density). The expression Erf stands for the probability integral, Erf (x) being the equivalent of

$$\frac{2}{\sqrt{\pi}}\int_0^x e^{-\beta^2} d\beta.$$

The temperature-gradient at the surface, $\left(\frac{d\theta}{dX}\right)_0 = \frac{\theta_0}{h\sqrt{\pi t}}$

[3] R. J. STRUTT, Proc. Roy. Soc. 77A: 475. 1906.

[4] JOLY, Phil. Mag. 24: 694. 1906.

It remained for Holmes[5] to make the bold step which reconciles in a satisfactory manner all of the factors involved. Instead of attempting to calculate the age of the Earth, and thence the interior temperatures, from the surface gradient, he started with the age of the Earth as determined by other means, and from that datum calculated the total amount of radioactive material in the Earth and thence the present temperatures at various depths. Probably the most satisfactory estimate of the age of the Earth is based on the ratio of lead to uranium in various rocks, from which it appears that the oldest rocks were formed more than one thousand million years ago. If, with Holmes, we assume that the Earth has been cooling as a solid body for 1.6 thousand million years, it can be shown that the total amount of radioactive material in the Earth is that which would be contained in a layer 10 to 20 km. thick and of the same uranium- and thorium-content as found in ordinary granites. The relative importance of the heat generated by radioactive disintegration is thus determined, and therefore if only the "initial" temperature of the cooling sphere were known, the problem of the Earth's interior temperatures would be solved.

Some calculations have been made by Holmes,[6] and a curve of temperature *versus* depth is given by Jeffreys. So much depends on the initial conditions, however, that it seems worth while to re-examine the factors which determine the cooling of the primitive Earth, and on the basis of the most reasonable starting point to calculate the temperatures at depths of a few hundred kilometers.

THE "INITIAL" DISTRIBUTION OF TEMPERATURE IN THE EARTH

In order to determine the conditions existing at the time the Earth began to cool according to the laws for a solid sphere, and in particular to fix upon the most probable initial surface temperature and temperature-gradient, it is necessary to consider how the Earth was formed. There now seems little doubt that this planet, in common with the other planets of the solar system, was generated by tidal disruption of the sun by the close approach of another star. But whether we accept the Planetismal Hypothesis in approximately its original form, or whether we incline toward the modified theories of Jeans[7] or of Jeffreys,[8] the facts of geology apparently demand that the Earth at

[5] A. Holmes, Geol. Mag. VI, 2: 60–71, 102–112. 1915; 3: 265–74. 1916.

[6] A. Holmes, *loc. cit.;* H. Jeffreys, *The Earth*, chap. VI. 1924.

[7] J. H. Jeans, *Problems of Cosmogony and Stellar Dynamics*. 1919.

[8] H. Jeffreys, *The Earth*, pp. 16–35, 1924.

some time in its history was covered with a molten layer of considerable thickness; and since at the moment we are concerned with the temperatures at depths of only a few hundred kilometers, it will suit the present purpose to deal with a molten sphere at a very high temperature and to consider the manner of its cooling.

The factors which determine the "initial" condition of the Earth. Cooling, at first, would be almost entirely by convection and would be very rapid. The surface layer, being at a high temperature, would lose heat rapidly by radiation, and the cooler, and hence denser, material would sink and be replaced by fresh, hot liquid. But convection, no matter how rapid, and even if the cooling at the surface were temproarily stopped, would not cause the temperatures to become the same at various depths. A convective equilibrium[9] would be attained, and the temperature would increase with depth according to a simple relation,[10] involving principally the expansion coefficient and the specific heat. From the available data for silicates, it appears that the temperature-gradient during the period of convective cooling was something less than 1°C. per kilometer depth.

As the Earth continued to cool, convection, and the consequent rapid cooling, would be terminated by one of two circumstances. Either (1) the liquid would solidify (*i.e.* crystallize), or (2) at a sufficiently low temperature it would become so viscous that it could no longer circulate readily. The melting-points of ordinary silicates increase with pressure and hence with depth. The rate of increase may be calculated from the latent heat of fusion and the volume change when melting takes place, that is, the difference in specific gravities of solid and liquid.[11] The increase of melting-point with depth has been placed by various investigators at 2.5 to 5°C per km. How much this rate changes under great pressures is unknown, but for moderate depths we may let the straight line marked *M* in figure 1 represent the melting-point depth relation.

[9] *Cf.* THOMSON and TAIT, *op. cit.*, p. 481.

[10] The relation between temperature and pressure for a fluid in convective equilibrium is $\frac{dT}{dp} = \frac{\alpha T}{c_p}$, in which T is the absolute temperature, p is the pressure, α is the coefficient of expansion, and c_p is the specific heat at constant pressure.

It may be noted that this same relation determines the temperature of the air at various heights above the surface of the Earth—at least in that part of the atmosphere in which convection takes place.

[11] The relation is the well-known Clausius-Clapeyron equation: $\frac{dT}{dp} = \frac{T\Delta v}{\Delta h}$ in which T is the absolute temperature, p is the pressure, Δh is the latent heat of fusion, and Δv is the difference in specific volumes of solid and liquid.

Before considering how this variation of melting-point influenced the conditions under which the Earth first began to cool as a solid body, let us consider how the other factor, viscosity, varies with depth. From measurements on the extrusion of marine glue, Barus[12] found that the viscosity bore a logarithmic relation to the temperature, that is,

$$\log \eta = A - Bt \tag{1}$$

η being the viscosity, t the temperature, and A and B constants. The recent measurements of Washburn, Shelton, and Libman[13] and of English[14] on various glasses over a large range of temperatures show that although the simple logarithmic relation does not apply at the higher temperatures, yet at the lower temperatures, where the viscosity is great, it fits with considerable accuracy. Thus for a soda-lime glass containing essentially 75 SiO_2, 14 Na_2O, and 11 CaO, equation (1) is sufficiently accurate when the viscosity is higher than about 10^7, that is, for temperatures from about 800° down to 550°, which was the lowest temperature at which measurements could be made.

It is probable that the variation of viscosity with *pressure* also follows a logarithmic relation. Barus found that his results for marine glue under various pressures could be represented by the equation:

$$\log \eta = A' + B'p \tag{2}$$

in which A' and B' are constants. The measurements by Hyde[15] on lubricating oils under pressures up to 1200 atmospheres satisfy this equation with fair accuracy. Now if B' be independent of t, and if B be independent of p, we have a very simple expression for the slope of the lines of constant viscosity (isogons). From equations (1) and (2) we have:

$$\left(\frac{dt}{dp}\right)_\eta = \frac{B'}{B} \tag{3}$$

from which it follows that a straight line, such as VV in figure 1, may represent the way in which the temperature must vary with the depth in order that a given viscosity may be maintained. The determination of the slope of this line requires data on the viscosity of silicates at high pressures. In the absence of such data, we must

[12] C. Barus, Am. Journ. Sci. (3) 45: 87–96. 1893.

[13] E. W. Washburn, G. R. Shelton and E. E. Libman, *The viscosities and surface tensions of the soda-lime-silica glasses at high temperatures.* Bull. Univ. of Ill. 21: No. 33, 1924.

[14] S. English, Journ. Soc. Glass Techn. 7: 25. 1923; 8: 205. 1924.

[15] J. H. Hyde, Proc. Roy. Soc. London 97: 240. 1920.

content ourselves with the supposition that $\left(\frac{dt}{dp}\right)_\eta$ is of the same order of magnitude for various viscous liquids. For marine glue the measurements of Barus give $B'/B = 0.0048$. For petroleum oils we have from Hyde's data, $B' = 0.0014$, but although the viscosity of these oils at room temperatures and higher has been thoroughly investigated, there are no data for the effect of temperature in the region in which the viscosity is very great and in which equation (1) would be expected to apply. However, from the results of Lane and Dean[16] it is probable that B is greater than 0.03, from which it follows that B'/B is less than 0.047. If, for liquid silicates the value of B'/B is of the same order of magnitude as for the above substances, then we may conclude (from admittedly slender evidence) that molten rock must be heated from 1° to 10° for each kilometer depth in order to maintain the same viscosity.

It is very interesting that the three kinds of equilibrium that come into play during the *early* cooling of the Earth—involving (1) convection, (2) melting-point and (3) viscosity—yield about the same temperature-gradient; thus, for (1) the gradient is a little less than 1° per kilometer; for (2) 2.5° to 5° per km.; and for (3) probably 1° to 10° per km.

Is the interior crystalline or vitreous? In the early stages of cooling the downward increase of temperature is determined almost entirely by the gradient for convective equilibrium. Referring to Fig. 1 let the dotted lines numbered 1 to 6 represent the temperatures in the molten outer part of the Earth at six successive epochs. These lines are straight except near the surface at a time just before complete solidification, when convection will be restricted and the superficial temperature will be lower than normal. The line MM is the melting-point line, and VV is the line indicating for each depth the temperature below which the viscosity is so great that convection is inappreciable. Two important cases may be distinguished: (a) in which the slope of MM is greater than that of VV, and (b) in which VV has the greater slope, so that the two lines cross at the depth D. In case (a) the convective cooling is terminated by crystallization at all depths, except possibly near the surface, but in case (b), before the true freezing-point is attained, the material at depths below D has become too viscous to circulate. Hence at these depths the liquid does not cool enough to crystallize but remains vitreous, while the material at

[16] F. W. LANE and E. W. DEAN, Journ. Ind. and Eng. Chem. 16: 905–911. 1924.

lesser depths than D is crystalline. In case (b), then, the Earth would consist of a layer of crystalline rocks of thickness D, and below this there would be non-crystalline or glassy silicates.

In the present state of our knowledge of the physical properties of silicates under combined high pressures and temperatures it would appear to be impossible to decide between these two cases. Yet a certain amount of light is shed on the question through consideration of the fact that down to considerable depths the Earth is highly elastic to forces whose duration is measured by days or even months. If we calculate the cooling which has taken place at these great depths[17] since the time of solidification, we can form a rough idea as to whether the lowering of temperature is sufficient to enable the glassy material to exhibit the requisite rigidity. Taking the age of the Earth as 1600 million years, the diffusivity as 0.007, and the original gradient as 4° per km., we find that at 600 km. the cooling would have been 180°, and at 1000 km. only 77°. Now the viscosity of an ordinary soda-lime glass[18] at 800° is such (one thousand million times that of water) that convection would surely be neglible, and yet at 500° it yields appreciably to stresses whose duration is only a few minutes. Hence this glass, from the time when convection was inoperative until the time when a high rigidity was apparent, would be required to cool

[17] This is a wholly different problem from the one with which this paper principally deals, namely, the actual temperatures at relatively small depths. For the cooling at great depths the problem to be solved is the cooling of a sphere (curvature not neglected), with constant surface temperature equal to zero and with an initial temperature which varies linearly with the depth, that is, $\theta = \theta_0 + b(R - r)$. Here, θ is the temperature at any distance r from the center, θ_0 is the initial surface temperature, R is the radius of the Earth, and b is a constant. The solution, which may be obtained by substituting in the general equation (No. 40 on page 133 of *An introduction to the mathematical theory of heat conduction,* Ingersoll and Zobel) is as follows: $\theta = \theta_0 \phi_1 + \mathrm{b}R\, \phi_2$.

where
$$\phi_1 = \frac{2\,R}{\pi\; r} \sum_{m=1}^{m=\infty} \frac{1}{m\,(-1)^{\,m+1}}\, \mathrm{e}^{-m^2 F} \sin \frac{m\,\pi\, r}{R}$$

and
$$\phi_2 = \frac{8\;R}{\pi^3\, r} \sum_{m=1}^{m=\infty} \frac{1}{(2\,m-1)^3}\, \mathrm{e}^{-(2\,m-1)^2 F} \sin \frac{(2\,m-1)\,\pi\, r}{R}$$

in which F is written for $\dfrac{\pi^2\, h^2\, t}{R^2}$

At depths greater than 600 km. radioactive heat would have no appreciable effect on the cooling, and may therefore be neglected for the purposes to which this equation is applied.

[18] Containing essentially 75 SiO_2, 14 Na_2O and 11 CaO.

more than 300°. Other commercial glasses, such as those made from baryta, zinc oxide, and silica with a little boric acid but no alkali, have a shorter "setting" range, but it is improbable that any known glass will require less than 200° drop in temperature to convert it from a liquid which could show appreciable convection into a "solid" which would be elastic toward stresses of moderate duration. The cooling at 600 km. (180°) is nearly the requisite amount, but the cooling at 1000 km. depth (77°) is inadequate.

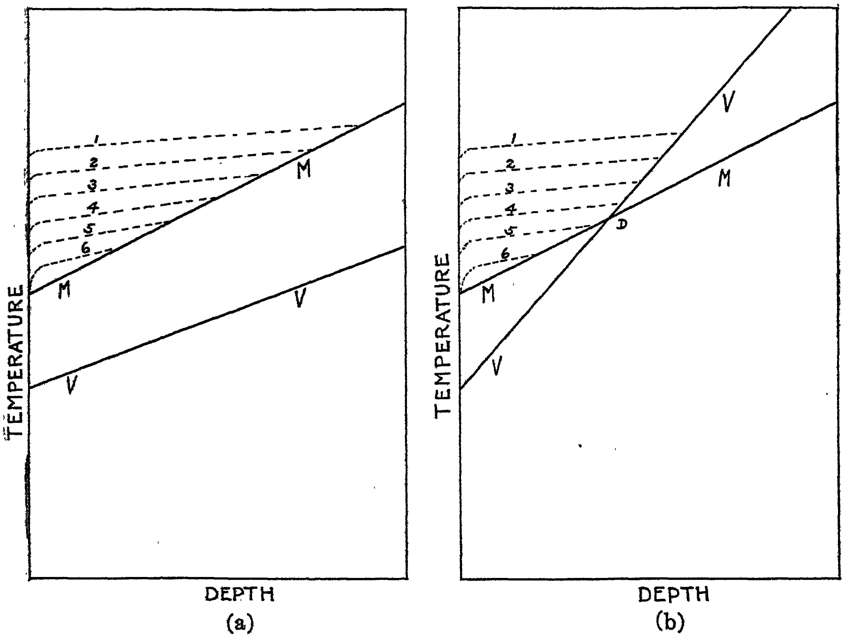


Fig. 1. Diagram to indicate conditions which determined the temperatures during the cooling of the molten outer part of the Earth. The line MM shows the freezing point of the rock at various depths, the line VV the temperature at which the molten material, at various depths, would become too viscous to circulate by convection. In (a) VV has a lesser slope than MM, and in (b) a greater slope. The dotted lines show the temperatures arising from free convection in the liquid layer. For case (a), the convection is terminated by crystallization at all depths (except very near the surface); but in case (b) the material at great depths remains glassy.

This cooling depends on the age of the Earth, on the diffusivity and on the initial temperature gradient, and it increases with each of these factors. The figure for the age of the Earth can not be increased very much above the value given, and the diffusivity of the deep-seated basic magma, can not be much higher than 0.007 but it is of course possible that the initial gradient is considerably higher than the value taken. Moreover, we must admit important geologic evidence as to

the existence of deep-seated liquid layers; but although the question must still await a definite answer, it seems probable that a large part, at least, of the upper two thousand kilometers of the Earth is crystalline. This conception, however, does not exclude the existence, comparatively near the surface, of considerable masses of liquid or glassy material even in late geologic times. Moreover, the central portion of the Earth, that is, the material at depths below 2000 km., may be non-crystalline. But, be that as it may, the immediate object of this note is not to inquire too deeply into these matters, but rather to estimate the original thermal condition of the outermost one or two thousand kilometers as a basis for calculating the present temperatures at moderate depths; and it is sufficient for the present to assume an initial gradient corresponding to the melting-point line. We may use this as our starting-point, with reasonable assurance that even if it is viscosity and not crystallization which determined the temperatures in the newly "solidified" Earth, the initial thermal gradient would be of the same order of magnitude.

The initial temperatures near the surface. Based on the preceding remarks, the simplest picture of juvenile Earth is as follows: The primitive molten magma, consisting almost entirely of magnesium iron silicates[19] with very small amounts of other ingredients such as alkali, lime, alumina, and water, began to crystallize at considerable depth, producing peridotite, which contained less of the minor constituents than the liquid phase. As crystallization proceeded, the minor constituents, including water, were concentrated to a greater and greater extent in the remaining liquid. Finally, when the liquid layer had been reduced to a thickness of 100 km. or less, it may be supposed to have become sufficiently rich in alkali, lime, and alumina to correspond in composition to a typical diabase. As cooling continued, further crystallization at the bottom of the liquid layer would take place, but at this time other important factors would enter. The surface of the liquid would always be a little colder than the temperature corresponding to straight-forward convective equilibrium, as indicated by the curvature, near the surface, of the dotted lines in figure 1. Thus, in this last stage of solidification, incrustation of the surface would go on simultaneously with the freezing at the bottom of the liquid layer, until finally, by the sinking of the heavier solid

[19] By comparison of the elastic constants of various rocks under high pressure with the values of the elastic constants of the material in the interior of the Earth as deduced from seismologic data, it is almost certain that the silicate portion of the Earth at depths greater than about 60 km. has the composition of an ultrabasic rock.

through the lighter liquid, the honeycombed solid and liquid structure postulated by Thomson and Tait[20] would be formed. Moreover, it is probable that somewhere between the outer crust and the deep-seated solidified material there would be liquid layers of great extent and thickness. We may conclude, then, that whether the Earth at a depth of several hundred kilometers be now crystalline or whether

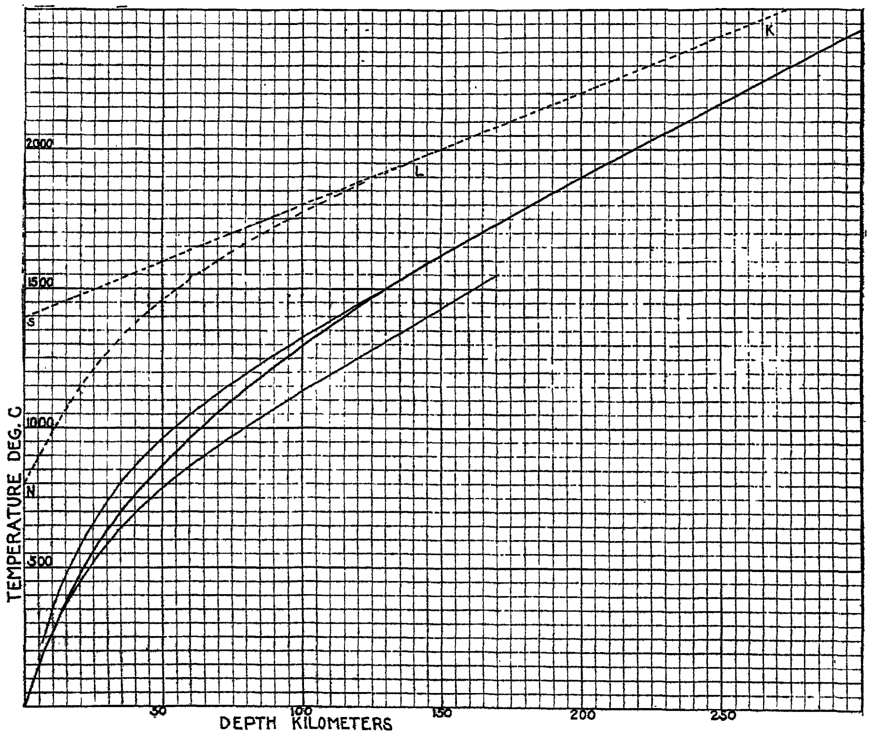


Fig. 2. The heavy line indicates the most probable temperatures at various depths down to 300 km. (180 miles). The "initial" temperature is shown by the line NLK, but the line SLK leads to substantially the same result, because the present temperatures of the Earth are independent of the original temperatures in the upper 100 km.

it be glassy, in either case there would be ample opportunity for the existence of large bodies of liquid beneath the outer crust and relatively near the surface.

As regards the temperatures near the surface at the time of initial solidification, it is plain that continued crystallization would, on the average, lead to a still further concentration of the "minor" con-

[20] THOMPSON and TAIT, *op. cit.*, p. 484.

stituents in the liquid until finally it had the composition of a granite.[21] The freezing-point of the liquid would thus be lowered by an increasing amount as the era of practically complete solidification approached. It is altogether probable that the "initial" temperature of the Earth, that is, the temperature immediately after convective cooling had ceased to play its rôle, was approximately as indicated by the line NLK in figure 2. At great depths this line merely represents the melting-point of peridotite at various pressures or depths, while near the surface it gives expression to the fact that there is an additional lowering of the melting-point due to the increasing amounts of "minor" constituents in the liquid.

PROBABLE TEMPERATURES IN UPPER 300 KILOMETERS

From the initial temperature distribution based on the above discussion we may now proceed to calculate the present-day temperatures at moderate depths. For the age of the Earth we shall take 1.6×10^9 years, or 5×10^{16} seconds; for the melting-point of peridotite, 1400°C; and for the increase of the melting-point with depth, 0.00004° per centimeter of 4° per kilometer.[22] This defines the line LK of figure 2. The exact position of the line NL is much more difficult to determine, but fortunately it so happens that when we write down the equation for the temperatures ensuing from the initial distribution NLK, and calculate the temperatures at various depths,[23] we find substantially the same temperatures as if the starting point had been straight line SLK. Thus, on account of the very great age of the Earth, *the temperatures at various depths within the Earth are unaffected by any reasonable variation of the initial temperatures in the upper 100 kilometers*. The present temperatures depend almost entirely on the original temperatures at considerable depths.

[21] See N. L. Bowen, *The later stages of the evolution of the igneous rocks.* Journ. Geol. 23, Supplement to no. 8, 1923, and in particular, pp. 66 to 75.

[22] This is believed to be the most appropriate value for an ultrabasic rock. It is based on a latent heat of 100 cal./g. and a volume change on melting of 0.04 cm^3/g.

[23] The line NLK is represented by the equation: $\theta = \theta_0 + mx - (\theta_0 - \theta'_0)e^{-bx}$ in which θ is the temperature at any depth x, θ_0 and θ'_0 are the temperatures at S and N respectively, m is the slope of the line SLK and b is another constant. The solution for this case differs from equation (4) by the addition, on the right hand side, of the term:

$$\frac{\theta_0 - \theta_0'}{2} e^{\gamma_1^2} \left\{ e^{-bx} \operatorname{Erc}(\gamma_1 - \lambda) - e^{bx} \operatorname{Erc}(\gamma_1 + \lambda) \right\}$$

in which $\gamma_1 = bh\sqrt{t}$. With b equal to 0.03×10^{-5}, this term is unimportant after an elapsed time of 100,000,000 years, and practically negligible after 300,000,000 years.

The solution for the cooling of a body, the surface of which is maintained at the constant temperature, zero, and which contains radioactive matter is as follows:[24]

$$\theta = m\,x + \left(\theta_0 - \frac{A}{a^2\,k}\right) \mathrm{Erf}\,\lambda + \frac{A}{a^2\,k}\left(1 - \mathrm{e}^{-ax}\right)$$
$$+ \frac{A}{2\,a^2\,k}\,\mathrm{e}^{\gamma^2}\left\{\mathrm{e}^{-ax}\,\mathrm{Erc}\,(\gamma - \lambda) - \mathrm{e}^{ax}\,\mathrm{Erc}\,(\gamma + \lambda)\right\} \tag{4}$$

The initial temperature is equal to $\theta_o + mx$, where θ_o is the temperature of S in figure 2, m is the slope of the line SK, and x is the depth. The amount of radioactive material is supposed to vary exponentially[25] with the depth, that is, at any depth heat produced per cm^3 per second is $A\mathrm{e}^{-ax}$. where A is the amount of heat produced in the surface layer and a is a constant. In equation (4) k is the thermal conductivity and h^2 is the thermal diffusivity, λ stands for $x/2h\ \sqrt{t}$, and γ for $ah\ \sqrt{t}$. If we differentiate this equation with respect to x and put x equal to zero, we have, to a sufficient approximation:

$$\left(\frac{\mathrm{d}\theta}{\mathrm{d}x}\right)_0 = m + \left(\theta_0 - \frac{A}{a^2\,k}\right)\frac{1}{h\sqrt{\pi\,t}} + \frac{A}{ak} \tag{5}$$

Since $(\mathrm{d}\theta/\mathrm{d}x)_o$, m and θ_o are given, equation (5) can be used to calculate a, the constant which determines the distribution of radioactive material.

The first step in the calculation of temperatures is to assign values to h and k. Now, the large variation in initial temperatures near the surface was a difficulty easily circumvented, but another and more serious difficulty arises from the fact that the conductivity of the salic rocks of the superficial layer is different from that of the femic rocks in the interior. It would be difficult to construct an equation to represent the temperatures in a region of varying conductivity, but we may take advantage of the fact that near the surface the temperature is determined by the physical properties of granite, and that in the interior the temperatures are nearly the same as if the granite were

[24] Ingersoll and Zobel, *An introduction to the mathematical theory of heat conduction*, equation 85, p. 95, 1913. In this solution the curvature of the Earth's surface is neglected—a procedure which is justifiable for the calculation of temperatures at moderate depths.

Erf λ is written for $\frac{2}{\sqrt{\pi}}\int_0^\lambda \mathrm{e}^{-\beta^2}\mathrm{d}\beta$ and Erc $(\gamma - \lambda)$ for $1 -$ Erf $(\gamma - \lambda)$.

[25] Any other assumption which makes the radioactivity decrease with depth gives nearly the same result.

not present. We therefore calculate two curves, one for salic rocks and one for femic rocks, and, by a somewhat arbitrary transition-curve, pass from one to the other in the region of supposedly variable composition.

For the conductivities (k) of salic and femic rocks, giving most weight to the measurements of Stadler[26] and less weight to the numerous other determinations, let us take 0.007 and 0.0055, respectively. Combining this with the densities 2.8 and 3.3, and the specific heat 0.25 for both kinds of rocks, we have 0.010 for the diffusivity (h^2) of surface rock, and 0.0067 for the deep-seated material.

For the superficial thermal gradient $(d\theta/dx)_o$ we have the careful measurements of Van Orstrand[27] in a number of borings in the United States. The gradient in the deeper parts averages about 0.00032° per cm., or 32° per kilometer. Now, the tendency is probably to underestimate rather than to overestimate the true superficial gradient, and we shall take 0.00035 as the value of $(d\theta/dx)_o$ in salic rocks. Furthermore, since for the same amount of heat passing through different materials the gradient is inversely proportional to the conductivity, we shall take $\frac{0.007}{0.0055} \times 0.00035$, or 0.00045 for $(d\theta/dx)_o$ in the femic rocks.

By equation (5) the value of a turns out to be 0.5×10^{-6} from the constants for both salic and femic rocks. This, it may be noted, means that the total amount of radioactive material in the Earth corresponds to a layer 20 km. thick and of the same content of radioactive material as the ordinary rocks found at the surface.

From the constants, as given, the two curves for salic and femic rocks were calculated by equation (4). These two curves (light lines), together with the final temperature-curve (heavy line) are shown in Fig. 2, which also shows (dotted lines) the supposed initial temperature distribution in the Earth. It may be seen that according to this diagram the temperatures at moderate depths are much lower than have often been supposed. Thus, at 100 km. the temperature is 1300°, while by extrapolation of the superficial gradient it would be over 3000°.

[26] G. STADLER, Dissertation, Berlin, 1889. See also, Landolt-Börnstein-Meyerhoffer, Phys.-chem. Tab., (5th ed.) II: 1295–8. 1923, and KARL SCHULZ, Fortschr. Mineral. Krist. Petrog. 9: 221–411. 1924.

[27] See WHITE and VAN ORSTRAND, Bull. W. Va. Geol. Survey, 1918, See also, N. H. Darton, Bull. U. S. Geol. Survey, no. 701, 1920; and R. A. Daly, Am. Journ. Sci. 5: 354. 1923.

Finally, it should be emphasized that the temperatures of figure 2 apply primarily to continental regions, and represent merely the average thermal condition at various depths; the possibility of locally higher temperatures is not excluded.

SUMMARY

In order to calculate the temperatures within the Earth it is necessary to determine the initial temperature-distribution, that is, the thermal condition at the time the Earth began to cool as a solid body. Then—as pointed out by Holmes—from the age of the Earth as fixed by the lead-uranium ratio in the oldest known rocks, from the present thermal gradient at the surface, and from the known amount of radioactive elements in superficial rocks the temperatures within the Earth can be calculated, due allowance being made for the heat produced by radioactive disintegration.

The present calculation extends to 300 km. depth and is based on an initial temperature-distribution arising from the crystallization, from the bottom upwards, of the primitive magma, which is believed to consist almost entirely of iron-magnesium silicates, corresponding to a peridotite rock. It is shown that if the material at great depths is not crystalline, but glassy, then the initial thermal condition would have been approximately the same. It is also shown that the initial temperature in the upper 50 or 100 km. could have no effect on the present-day temperatures—the temperatures at moderate depths are determined almost entirely by the original temperature at depths greater than 100 km.

The temperature curve here given makes no pretense of finality, but it may be a useful guide in discussions involving the deeper parts of the Earth's crust.

ENTOMOLOGY.—*The subfamilies, tribes, and genera of American Culicidae.* HARRISON G. DYAR and RAYMOND C. SHANNON, U. S. National Museum (Communicated by S. A. ROHWER.)

The Culicidae are a homogeneous group of insects presenting, particularly in the adult stage, a paucity of characters, so that their classification, on a natural basis, has been exceedingly difficult. A natural grouping for the family was finally effected by a study[1] based principally on larval characters. Characters mainly genitalic were also

[1] DYAR and KNAB; Journ. N. Y. Ent. Soc. 14: 170. 1906.

used for the adults and the subgroups were thereby correlated with those recognized in the larval stage. However, keys based on external adult characters were difficult and rather unsatisfactory.

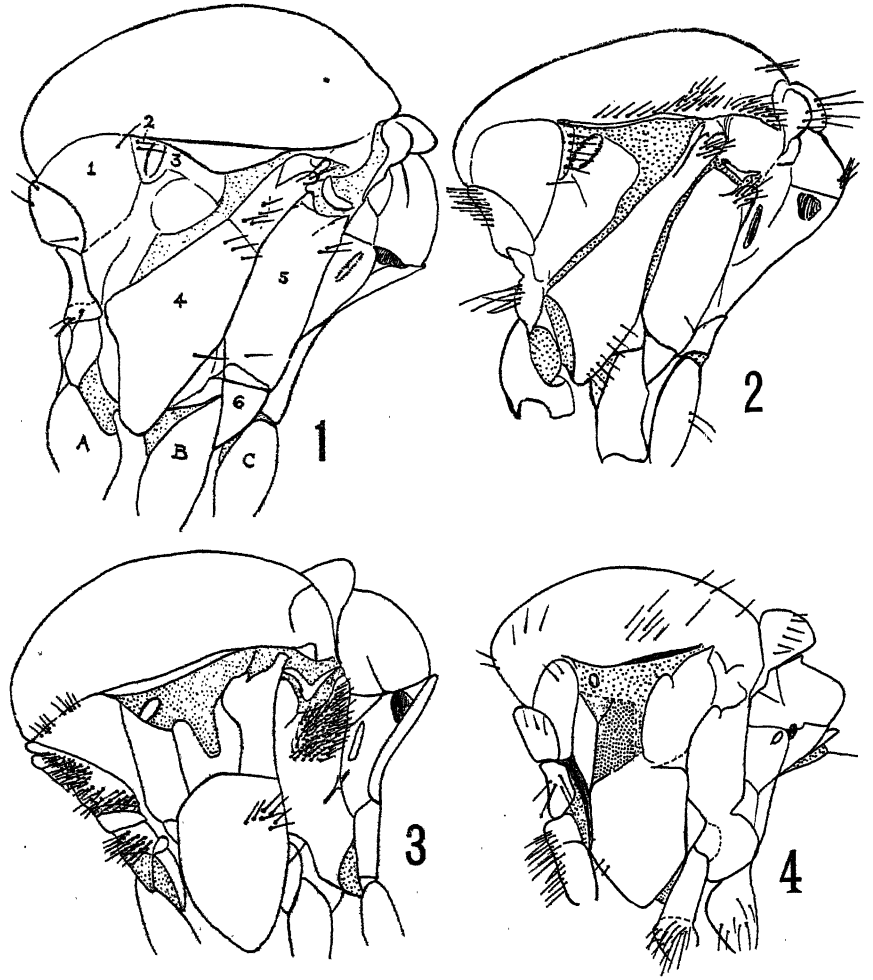
Gradually our knowledge of the external, generic, tribal, and subfamily characters of the adults has increased. Recent publications by Edwards add important characters, and studies made by the present authors have revealed more. In view of this, it appears worth while to publish a revised synopsis of the subfamilies, tribes, and genera of the American Culicidae. The characters here used are based primarily on the American forms.

The keys to the genera of adult mosquitoes given in F. W. Edwards' publications, *A revision of the mosquitoes of the Palearctic Region* (1921) and *A synopsis of adult oriental Culicine, including Megarhinine and Sabethine, mosquitoes* (1922), include many excellent characters based on the distribution of the setae in the adult. The use of these characters, while bringing about very little change in the status of the genera as already established, frequently proves very helpful as a further means of defining the genera. However, their use is limited, and apparently does not furnish the means for a natural classification throughout. The spiracular setae, which Edwards considers the most important for taxonomic purposes, are sporadic in their occurrence. These occur in *Megarhinus, Anopheles, Uranotaenia, Culiseta, Psorophora,* and the Sabethini except *Limatus,* and are absent in *Culex, Mansonia, Aëdes, Haemagogus, Orthopodomyia, Aëdeomyia,* and *Limatus*. Obviously this would be an unnatural grouping.

This indicates the necessity of using the setal characters with caution, as Edwards has done, especially as other sets of setae are still less reliable. The pronotal (proepimeral) setae in some instances are unreliable even for specific purposes; but Matheson[2] on the strength of this character would raise the subgenus *Janthinosoma* to generic rank and include in it all the species of *Psorophora* possessing pronotal setae. He believed that *P. howardii,* which has pronotal setae, should be transferred to *Janthinosoma*. However, *howardii* is a typical *Psorophora,* even in the restricted sense, and accordingly the presence or absence of pronotal setae fails here to have generic value. As a matter of fact, this character proves too variable even for specific purposes, for in the species *ciliata,* upon which Matheson bases his observations, they are present or absent. A similar condition occurs in *Isostomyia;* pronotal setae are present in certain species and absent in others.

[2] Canad. Ent. **56**: 160.

Edwards has divided the genus *Mansonia* (*Taeniorhynchus*) into two groups, *Coquillettidia*, with the postspiracular setae absent, and *Mansonia* (*Taeniorhynchus*) + *Mansonides*, with these setae present.



LATERAL VIEW OF THE THORAX OF CHARACTERISTIC GENERA OF CULCIDAE

Fig. 1. *Uranotaenia.* 1, Pronotum (proepimeron of Edwards); 2, spiracular sclerite and setae; 3, mesopleural (bears the postspiracular setae if present); 4, stenopleura; 5, mesepimeron; 6, lateral sclerite of metasternum; A, B, C, fore, mid, and hind coxae. Fig. 2. *Joblotia.* Fig. 3. *Eucorethra.* Fig. 4. *Dixa.*

He places the American species (*fasciolatus*, *nigricans*, *arribalzagae*, *justamansonia*, *?hypocindynia*, *?albicosta*) in *Mansonia* on account of the presence of these setae. Based on genitalic and scale characters

of the adult there are also two groups, though the American species above mentioned belong to *Coquillettidia* and not to *Mansonia*. This forms an unnatural association as these American species are more nearly allied to *Coquillettidia* than to *Mansonia* in general characteristics. They can be accommodated by the erection of a fourth subgenus, but the setal character by itself is seen to be of less than subgeneric value.

The character of the lateral metasternite in reference to the hind coxa, here used to separate the Megarhinini and Sabethini from the other mosquitoes, is constant for the American forms, and for this reason the Sabethini have been maintained as a tribe apart from the Culicini.

The generic names are here used in the same sense as in the Monograph[3] by Howard, Dyar and Knab, except in cases of subsequent changes.

The Chaoborinae (Corethrinae) and Dixinae, which are now generally regarded as true Culicidae, have been included in the key. Formerly they were usually omitted from the family because of the nonbiting habits and mouthparts.

The wing venation is the outstanding feature of all Culicidae, which, in its essential elements, is homogenous throughout the family and is not duplicated in other Diptera. The family may be characterized as follows: Antennae fifteen to sixteen jointed; ocelli absent; mesonotum without "V"-shaped suture; wing with ten longitudinal veins reaching the margin which are: Sc, R_1, R_2, R_3, R_{4+5}, M_{1+2}, M_3, Cu_1, Cu_2 and 2d A. The radial sector branches from the radius basad of r-m crossvein; second basal cell present; discal cell absent; anal cell widening toward wing margin; one anal vein present.

SUBFAMILIES OF CULICIDAE

A1. Eyes reniform; flagellum 13-jointed; proboscis extending far beyond clypeus; mesosternum ridged; sternopleura not divided by transverse suture (except Uranotaenini); lateral sclerite of metasternum triangular, in line with (Megarhinini, Sabethini) or below (Uranotaenini, Anophelini, Culicini), the base of hind coxa; wings scaled, hind margin with fringe of scales; Rs forking far before tip of Sc; upper squama bare or ciliated. . . . . *Culicinae.*

A2. Eyes more or less emarginated on mesal line; flagellum 13-jointed; proboscis extending very short distance beyond clypeus; mesosternum without ridge; sternopleura divided by transverse suture; lateral sclerite of metasternum much reduced, not triangular; wings with hair-like scales, hind margin with fringe of scales; Rs forking far before tip of Sc; upper squama ciliated. . . . . *Chaoborinae.*

[3] *The mosquitoes of North and Central America and the West Indies.* 1912.

A3. Eyes not emarginated, nearly circular in outline; flagellum 14-jointed; proboscis not extending beyond clypeus; mesosternum without ridge; sternopleura nearly divided by a median transverse suture; lateral sclerite of metasternum much reduced, not triangular; wings with only inconspicuous hairs on veins, hind margin with fringe of sparse hairs; Rs forking approximately opposite tip of Sc; upper squama not ciliated..*Dixinae.*

KEY TO THE GENERA OF AMERICAN CULICIDAE

A1. Proboscis extending far beyond clypeus:..........Subfamily *Culicinae.*
  B1. Base of hind coxa in line with upper margin of lateral metasternal sclerite; upper squama incompletely ciliated to bare; spiracular setae not absent when pronotal setae are present; (exclude *Haemagogus*, Culicini, by: spiracular setae absent; proepimeral setae present)..**Series A.**
    C1. Clypeus much broader than long; scutellar post margin evenly rounded; a spurious vein in Cu_1 cell; squama not ciliated; post notal setae absent....................MEGARHININI, *Megarhinus.*
    C2. Clypeus at least as long as broad; scutellum trilobed; no spurious vein in Cu_1 cell; post notal setae present; abdomen usually compressed and with few setae.........................SABETHINI.
      D1. No pronotal setae (lobes widely separated, see *Isostomyia espini*).
        E1. No prealar setae.
          F1. No propleural setae.............................*Sabethes.*
          F2. Propleural setae present.......................*Sabethoides.*
        E2. Prealar setae present.
          F3. No spiracular setae............................*Limatus.*
          F4. Spiracular setae present.
            G1. Lower sternopleurals distinctly below upper margin of lateral metasternal sclerite.
              H1. Wing scales especially the outstanding scales on bases of R_2 and R_3 broad...........................*Miamyia.*
              H2. Wing scales narrow..........................*Wyeomyia.*
            G2. Lower sternopleurals, extending as far as, usually above, upper margin of lateral metasternal sclerite.
              H3. Wing scales narrow (rare)..................*Menolepis.*
              H4. Wing scales broad........................*Prosopolepis.*
      D2. Pronotal setae present (except *Isostomyia espini*).
        E3. Clypeus without setae.
          F5. Lower sternopleurals distinctly below upper margin of lateral metasternal sclerite; palpi very small in both sexes...*Isostomyia.*
          F6. Lower sternopleurals extending above upper margin of lateral metasternal sclerite; palpi not small.........*Goeldia.*
        E4. Clypeus setose.......................................*Joblotia.*
  B2. Base of hind coxa distinctly below upper margin of lateral metasternal sclerite; postnotum rarely setose; abdomen rarely compressed and with reduced setae. (The Sabethid-like genus *Haemagogus* is retained here on basis of absence of spiracular setae and presence of pronotal setae)..**Series B.**
    C3. Scutellum trilobed with marginal setae only on the lobes.

D3. Anal vein extending well beyond fork of cubitus; wings villose; upper squama ciliated (partially so in *Haemagogus* and *Carrollia*)..CULICINI.

E5. Prescutellar setae absent; wings narrower than width of thorax; postspiracular setae absent.....................*Haemagogus*.

E6. Prescutellar setae present; wings broader than width of thorax.

F7. Post spiracular setae present.

G3. Spiracular setae absent.

H5. Wing scales mostly narrow, or when broad (rare), setae are present on upper side of base of first vein....*Aëdes*.

H6. Wing scales broad; setae absent on upper side of base of first vein. (See *Mansonia*.)

G4. Spiracular setae present, sometimes small.....*Psorophora*.

F8. Post spiracular setae absent.

G5. Lower side of base of first vein distinctly pilose; spiracular setae present.............................*Culiseta*.

G6. Lower side of base of first vein scaly or bare; spiracular setae absent.

H7. No setae on upper side of base of first vein; wing scales broad, black and pale mixed (all black in some species of *Mansonia* which have post spiracular setae).

I1. No mid-mesepimeral setae; fourth tarsal joint of fore tarsus somewhat thickened, as broad as long, or broader........................*Orthopodomyia*.

I2. Mid-mesepimeral setae present; fourth fore tarsal joint longer than broad.

J1. Post marginal wing scales longer than width of anal cell; antennal joints but little longer than broad..............................*Adëomyia*.

J2. Post marginal wing scales shorter than width of anal cell; antennal joints much longer than broad..............................*Mansonia*.

H8. Setae present on upper side of base of first vein; wing scales mostly narrow, dark colored.

I3. Mid-mesepimeral setae numerous.............*Lutzia*.

I4. Mid-mesepimeral setae 0-3.

J3. Antenna much longer than length of proboscis. *Deinocerites*.

J4. Antenna approximating length of proboscis...*Culex*.

D4. Anal vein ending opposite or basad of cubital fork; squamae not ciliate; wings without villi. URANOTAENINI, *Uranotaenia*.

C4. Scutellum crescent-shaped, with marginal setae evenly distributed..............................ANOPHELINI, *Anopheles*.

A2. Proboscis not elongate, extending but little beyond clypeus.

B3. Radial sector forking far before tip of subcosta; wings with hair-like scales; hind margin with fringe of scales..Subfamily *Chaoborinae*.

C5. Anal vein ending basad of cubital fork................*Eucorethra*.

C6. Anal vein ending beyond fork of cubitus.

D5. Basitarsal joint shorter than following joint...........*Corethra*.

D6. Basitarsal joint longer than following joint.

E7. Tip of R_1 much nearer tip of R_2 than to Sc. . . . . *Chaoborus*.
E8. Tip of R_1 much nearer tip of Sc than to R_2. . . . . *Corethrella*.
B4. Radial sector forking approximately opposite tip of subcosta; wings with only inconspicuou shairs on veins, hind margin with fringe of sparse hairs. . . . . Subfamily *Dixinae*, *Dixa*.

Subfamily CULICINAE.

Series A.

Series A contains the tribes Megarhinini and Sabethini. The grouping apparently is not a natural one and for this reason no name is proposed. The species are all day-fliers which probably accounts for the brilliant metallic colors of the scales and their extensive development, which in turn has brought about a decrease in the setae. The position of the lateral metasternal sclerite and absence of squamal cilia may be due to similar causes.

Tribe Megarhinini.

The American species of this tribe are all contained in the genus *Megarhinus*. This group in many respects is the most peculiar of the Culicinae. It possesses many striking characters which set it well apart from all other genera.

It is interesting to compare a female of this non-bloodsucking group with the female of such a strong biter as *Psorophora ciliata*. In *Psorophora* there is a chitinous collar-like development from the lower part of the head which, with the clypeus, surrounds the base of the proboscis. It is completely absent in *Megarhinus* and apparently absent in all non-biting Culicinae.

Tribe Sabethini.

The Sabethini are among the most recent of the Culicidae and the most highly specialized in respect to vestiture and structure, yet apparently derived separately from a point low in the phylogeny, not improbably in the general vicinity of *Megarhinus*, which we associate in the same series on other characters. The *Joblotia* group is the least specialized of the Sabethini and in this group we find the male genital structures resemble not only those of *Megarhinus*, but also the lower genera of the Culicine series, *Bancroftia* and *Culiseta*. There is a correspondingly high degree of specialization in the life history, many of them being adapted to very peculiar habitats, such as aerial bromelias, in their immature stages, yet again, the specialization apparently originated from a point low in phylogeny, and the original Sabethine was doubtless a tree-hole breeder, as is the case with the lowest members of the Culicine series.

The Sabethes Group.

In *Sabethes* and *Sabethoides* the scale vestiture has been carried to the highest development, with a corresponding decrease of setae, that has been attained in the American Culicidae. A few exceptions are found in *Limatus*. The scales are mostly shining bluish black with violet and greenish reflections. The pleurae are more or less silvery, while the abdominal sternum has white scales, and certain species have white scales on the legs.

All mesonotal setae are absent except those on the post alar calli and the anterior margin; the prealar, pronotal and propleural (present in *Sabethoides*) are likewise absent, while the sternopleural setae are lacking except for the lowermost ones, and the mesepimeral setae are confined to a tuft on the upper posterior corner; squamal margins bare; abdomen compressed, almost

devoid of setae except on first tergite and terminal segments; wings narrower than width of thorax, with broad scales; second anal (axillary) cell broader than length of hind marginal fringe.

Genus **Sabethes** Robineau-Desvoidy.

Sabethes Robineau-Desvoidy, Mém. Soc. d'hist. Nat. Paris **83**: 411. 1827.

Characters for defining *Sabethes* are: propleural without setae; fore femur shorter than middle one; mid tibia with greatly developed, outstanding scales; hind leg elongate, its tarsus nearly three times as long as tibia.

Genus **Sabethoides** Theobald.

Sabethoides Theobald, Mon. Culic. **3**: 328. 1903.
Sabethinus Lutz in Bourroul, Mosq. do Brazil 48, 57. 1904.

This genus differs from *Sabethes* mainly by the presence of lower propleural setae; front femur as long as the middle one; absence of "paddles" on mid tibia.

The senior author was of the opinion[4] that *Sabethes* and *Sabethoides* were of not more than subgeneric value, and this view may yet obtain. However, in correspondence with the characters as here used, it seems best to give them full generic rank.

Genus **Limatus** Theobald.

Limatus Theobald, Mon. Culic. **2**: 349. 1901.
Lemmamyia Dyar, Ins. Ins. Mens. **7**: 140. 1919.

Limatus is a small group of brilliantly colored mosquitoes. The vestiture is composed of dense flat and appressed scales, with greatly variegated metallic colors, black, purple, golden, silvery, green, dark blue and reddish bronze. Mesonotum with setae only on anterior margin and post alar calli; spiracular and sternopleural setae present; prealar, propleural and tuft of mesepimeral setae present; wings as broad as thorax; wing scales broad; axillary cell but little broader than length of hind marginal fringe; hind tarsus with a single claw. The tip of the anal vein in some species ends opposite the cubital fork, as in *Uranotaenia*.

Limatus divides into two subgenera on the characters of the male hypopygium as follows:

Side piece short and unspecialized; clasper with two arms, one semiarticulate and opposed to the other........................*Limatus*.
Side piece angled, with a spine and large tuft of hairs at base; clasper capitate, indistinctly divided......................*Lemmamyia*.

Limatus contains *durhami* Theob. and *paranensis* Theob., possibly but varieties of one species.

Lemmamyia contains *asullepta* Theob. and *pseudomethysticus* B.-W. & B., possibly but varieties of one species.

The Wyeomyia Group.

This is a large group of species of unusual difficulty to classify. Usually only one genus, *Wyeomyia*, is recognized, but a large number of subgenera are in use. An attempt has been made here to divide *Wyeomyia* into four groups having generic rank on the basis of the pleural setae and wing scales.

Genus **Wyeomyia** Theobald.

Wyeomyia Theob., Mon. Culic. **2**: 267. 1901.
Phoniomyia Theob., Mon. Culic. **3**: 311. 1903.

[4] Ins. Ins. Mens. **12**: 97. 1924.

Pentemyia Dyar, Ins. Ins. Mens. **7**: 122. 1919.
Diphalangarpe Dyar, Ins. Ins. Mens. **7**: 126. 1919.
Dyarina Bonne-Wepster and Bonne, Ins. Ins. Mens. **9**: 6. 1921.
Phyllozomyia Dyar, Ins. Ins. Mens. **12**: 112. 1924.

Wyeomyia may be defined: Mesonotum with setae on anterior margin, on lateral margins, on post alar calli and with or without prescutellar setae; the spiracular, propleural and prealar setae present; sternopleura with setae only on lowermost portion; wing a little broader than thorax; wing scales narrow; second anal cell as broad or slightly broader than hind marginal fringe; abdomen with few setae except on first tergite and apically.

The following subgenera may be recognized on the characters of the male hypopygium:

A1. Clasper with capitate tip, a short arm on either side, in a few species absorbed into the head.
  B1. Stem of clasper short and stout.............*Phyllozomyia* Dyar.
  B2. Stem of clasper long and slender.............*Wyeomyia* Theob.
A2. Clasper with 3 arms, which are separate and without capitate tip.
  B3. The 3 arms approximate, 2 erect, 1 at right angles *Pentemyia* Dyar.
  B4. The 3 arms long and widely separated......*Dyarina* B.-W. & B.

Phyllozomyia contains the species *smithii* Coq., *vanduzeei* D. & K. *bahama* D. & K. and *chrysomus* D. & K.

Wyeomyia contains *pertinans* Will., *abebela* D. & K., *melanopus* Dyar, *quasiluteoventralis* Theob., *telestica* D. & K., ? *oblita* Theob.,? *celaenocephala* D. & K., *scotinomus* D. & K., *simmsi* D. & K., *camptocomma* Dyar., *mitchellii* Theob. and *guatemala* D. & K.

Pentemyia contains *bromeliarum* D. & K.

Dyarina contains *lassalli* B.-W. & B.,? *pallidoventer* Theob. and *leontiniae* Brèthes.

(*Menolepis*) *culebrae* Dyar falls into *Wyeomyia* and may be the female of *melanopus* Dyar in case the slight postnotal scaling proves to be sporadic. It is not present in the single male of *melanopus* before us.

Genus **Miamyia** Dyar.

Phoniomyia Theo., Mon. Culic. **3**: 311. 1903.
Miamyia Dyar, Ins. Ins. Mens. **7**: 116. 1919.
Cleobonnea Dyar, Ins. Ins. Mens. **7**: 105. 1919.
Dodecamyia Dyar, Ins. Ins. Mens. **7**: 138. 1919.
Shropshirea Dyar, Ins. Ins. Mens. **10**: 97. 1922.

The chief difference to be noted between *Miamyia* and *Wyeomyia* is that in the former the wing scales are broad, and narrow in the latter.

The subgenera of *Miamyia* separate as follows:

A1. Clasper with 3 short arms and a fourth downturned one; tenth sternite produced with tuft of spines or long hairs; lateral angles of 8th segment roundly produced........................*Miamyia* Dyar.
A2. Clasper varied but otherwise; tenth sternite normal; angles of 8th segment not produced.
  B1. Clasper with 3 or 4 similar arms, one of them triangularly widened.................................*Cleobonnea* Dyar.
  B2. Clasper with the arms irregular and unlike, a tuft of hair from near apex of side piece.........................*Shropshirea* Dyar.
  B3. Clasper simple, without branches............*Dodecamyia* Dyar.

Miamyia contains: *codiocampa* D. & K., *serrata* Theob. and *hosautus* D. & K.

Cleobonnea contains: *occulta* B.-W. & B., ?*argenteorostris* B.-W. & B. and *negrensis* G. & E.

Shropshirea contains: *ypsipola* Dyar.

Dodecamyia contains: *aphobema* Dyar (wing scales broadly ligulate), *bodkini* Edw., ?*longirostris* Theob. (if this species actually falls here, the subgeneric name must be changed to *Phoniomyia* Theob.), *splendida* B.-W. & B., ?*trinidadensis* Theob., ?*quasilongirostris* Theob., ?*roucouyana* B.-W. & B., ?*grenadensis* Edw.

The senior author proposed to unite *clasoleuca* D. & K., *grenadensis* Edw. and *roucouyana* B.-W. & B. as one species (Ins. Ins. Mens., XII, 109, 1924); but according to the setal characters *clasoleuca* and *roucouyana* must be separated; *grenadensis* is not before us.

Genus **Prosopolepis** Lutz.

Prosopolepis Lutz, Imp. Med. 312. 1905.
Dinomyia Dyar, Ins. Ins. Mens. **7**: 117. 1919.
Triamyia Dyar, Ins. Ins. Mens. **7**: 120. 1919.
Heliconiamyia Dyar, Ins. Ins. Mens. **7**: 123. 1919.
Decamyia Dyar, Ins. Ins. Mens. **7**: 135. 1919.
Hystatomyia Dyar, Ins. Ins. Mens. **7**: 140. 1919.
Calladimyia Dyar, Ins. Ins. Mens. **7**: 151. 1919.

Prosopolepis, as here defined, differs from *Wyeomyia* by having the lower sternopleural setae extending upwards as far as, or above, the dorsal margin of the lateral metasternal sclerite, and broad wing scales. In addition the wings in some species are comparatively larger with a broader second anal cell; the metanotum may be scaly (*Eunicemyia*); the clypeus may be scaly (*Prosopolepis*) and in certain species of *Hystatomyia* and *Prosopolepis* the number of spiracular setae are reduced to one or two. A number of species have 1–3 squamal setae.

Prosopolepis divides into the following subgenera on the characters of the male hypopygium:

A1. Clasper much complicated and branched.................*Dinomyia*.
A2. Clasper not much complicated, not over 3-branched.
  B1. Clasper short-stemmed, the division reaching near base *Prosopolepis*.
  B2. Clasper long-stemmed.
    C1. Clasper with a short branch near mid stem...........*Triamyia*.
    C2. Clasper with expansions and arms terminal or simple.
      D1. Clasper with three distinct separated arms at tip *Heliconiamyia*.
      D2. Clasper with 3 arms short and capitate
        E1. 3 setae near base of side piece normal.........*Calladimyia*.
        E2. 2 of these 3 setae separated and modified........*Decamyia*.
      D3. Clasper with long stem and expanded, irregular tip *Eunicemyia*.
      D4. Clasper simple or triangularly expanded at tip.
        E3. Angles of side pieces greatly produced, the clasper subterminal...........................*Hystatomyia*.
        E4. Side pieces normal, subspherical, clasper terminal *Janicemyia*.

Dinomyia contains: *phroso* H. D. & K., *mystes* Dyar.

Prosopolepis contains: *confusus* Lutz, *flui* B.-W. & B., *jocosa* D. & K. and *prolepidis* D. & K., but the male of the genotype is unknown, the characters being taken from *prolepidis*.

Triamyia contains: *aporonoma* D. & K., *personata* Lutz.

Helioconiamyia contains: *chalcocephala* D. & K.

Calladimyia contains: *melanocephala* D. & K.

Decamyia contains: *ulocoma* Theob., *pseudopecten* D. & K., *eloisa* H., D. & K.

Eunicemyia n. subgen., contains: *albosquamata* B.-W. & B. subgenotype and ?*hemisognosta* D. & K.

Hystatomyia contains: *intonca* D. & K., *circumcincta* D. & K., *coenonus* H. D. & K., *lamellata* B.-W. & B. and *autocratica* D. & K.

Janicemyia n. subgen. contains: *clasoleuca* D. & K. subgenotype.

Genus **Menolepis** Lutz.

Menolepis Lutz (Bourroul) Mosq. do Brazil 67. 1904.

This genus contains only a single species, *leucostigma* Lutz. The eyes are fairly well separated; the spiracular sclerite is densely scaly and only one seta is present; postnotum has a large patch of white scales; the wing scales are narrow and the upper squama has two setae. The male is unknown to us.

We are unable to place the following species: *luteoventralis* Theobald (genotype of *Dendromyia* Theob.), *bourrouli* Peryassú, *arthrostigma* Peryassú and *flavifacies* Edwards.

The Joblotia Group.

The genera *Isostomyia*, *Goeldia*, and *Joblotia* form a rather generalized group of Sabethini. The scale development and reduction of setae is not as extensive, while the wings are comparatively larger and squamal setae are usually present; the eyes are contiguous, and the male palpi are elongate and fairly long in the female (very small in both sexes of *Isostomyia*). One to four pronotal setae are usually present. The eyes are more or less separated in *Wyeomyia*, et al. (practically contiguous in *Prosopolepis prolepidis* D. & K.), and the prothoracic lobes are more approximated in the *Wyeomyia* group than in the *Joblotia* group, although *I. homotina* D. & K. has them somewhat approximated.

Genus **Isostomyia** Coquillett.

Isostomyia Coquillet, Class. Mosq. 16. 1906.

This genus includes *perturbans* Williston (genotype), *homotina* D. & K., *espini* Martini, and possibly *Dendromyia paranensis* Brèthes. It is separated from *Goeldia* by the small palpi in both sexes; and the sternopleura setae being distinctly below the upper margin of the lateral metasternal sclerite. The pronotal setae are absent in *espini* and *paranensis;* in *homotina* the second anal cell is broader than the length of the hind marginal fringe, in *espini* the cell is slightly narrower and in *paranensis* it is about equal to the length of the fringe.

Genus **Goeldia** Theobald.

Goeldia Theobald, Mon. Culic. **3**: 330. 1903.

The genus *Goeldia* is characterized by the presence of pronotal setae, widely separated prothoracic lobes, contiguous eyes; clypeus without setae; sternopleural setae extending above the upper margin of lateral metasternal

sclerite; palpi of female as long as or longer than width of head; palpi of male nearly as long as proboscis.

The species included are: *fluviatilis* Theob. (genotype), *longipes* Fabr., *lampropus* H. D. & K., *leucopus* D. & K., *rapax* D. & K., *lunata* Theob. *pallidoventer* Lutz, *trichopus* Dyar, *vonplesseni* D. & K. See also B.-W. & B. (Ins. Ins. Mens. **10:** 38. 1922), whose table of species includes also *Isostomyia.*

G. fluviatilis has the pronotal setae on the anterior portion of the pronotal sclerites. The thorax of *vonplesseni* presents peculiar features. It appears to be unusually elongated, from above appearing nearly three times as long as wide; in side view it is subquadrate instead of the usual wedge-shape; the roots of the wings instead of being directly above the hind coxae, are placed well behind them.

Genus **Joblotia** Blanchard.

Joblotia Blanchard, Comp. Rend. Soc. Biol. **53:** 1046. 1901.

The setose clypeus of *Joblotia* is a character peculiar to this genus.

Series B.

In this series of tribes and genera the base of the hind coxa is distinctly below the line of the upper margin of the lateral metasternal sclerite, except certain species of *Haemagogus;* pronotal (proepimeral) setae usually present; back of head usually with narrow erect scales (exceptions in *Uranotaenia, Haemagogus,* and certain species of *Aëdes* and *Culex*); body scales usually sparse and rarely with metallic colors; upper squama ciliated (except *Uranotaenia,* and partly so in *Haemagogus* and *Carrollia*); postnotum rarely with setae.

All of the known disease-carriers as well as the obnoxious species occur in this series.

Tribe Culicini

The tribe Culicini contains two well marked groups, *Aëdes* group and *Culex* group, with a number of intermediate genera. The shape of the female abdomen frequently offers a more ready means towards generic diagnosis than other characters used in the key. In the *Aëdes* group, *Psorophora, Aëdes,* and *Haemagogus,* the tip of the abdomen tends to be pointed, with the cerci exserted. Usually the other genera, *Culex, Lutzia, Deinocerites, Mansonia Aëdeomyia, Orthopodomyia,* and *Culiseta* have the tip of the abdomen markedly blunted. *Carrollia,* subgenus of *Culex,* has the abdomen strongly compressed. The *Aëdes* group has the eyes separated on the lower side of the head; in the *Culex* group they are contiguous; in the other genera the eyes are nearly touching below. The *Culex* group, *Culex, Lutzia,* and *Deinocerites* as recorded by Edwards, have distinct pulvilli.

The palpi of the females of Culicini are distinctly shortened, usually small.

Genus **Haemagogus** Williston.

Haemagogus Williston, Trans. Ent. Soc. Lond. 271. 1896.

Stegoconops Lutz, Imprensa Medica 83. 1905.

Haemagogus is remarkable for its most striking resemblance to the Sabethini, particularly the Sabethes group. Nearly all of the peculiarly Sabethine characters are duplicated in one or more species of *Haemagogus* and on the basis of external adult characters it can hardly be differentiated.

The extensive scale development with the resultant decrease of setae and the coloration is practically the same as in *Sabethoides;* likewise the prothora-

cic lobes are closely approximated, the metanotum frequently bears setae, the base of the hind coxae in some species is in line with the upper margin of the lateral metasternal sclerite, and the squamae are incompletely ciliated.

The main character by which *Haemagogus* is separated from the Sabethini is that the pronotal (proepimeral) setae are present while the spiracular setae are absent. Other characters are the more elongate head, narrower wings and shorter legs.

Stegoconops is retained as a subgenus of *Haemagogus* and may eventually have to be raised to generic rank.

Haemagogus leucomelas Lutz, on the basis of setal characters, postnotal and prescutellar setae present, must be referred to *Aëdes*. It represents a close intermediate stage between the two genera. As the name *leucomelas* is preoccupied the new name **Aëdes leucocelaenus** is proposed for it.

Genus **Aëdes** Meigen.

Aëdes Meigen, Syst. Beschr. bek. Eur. zweifl. Ins. **1:** 13. 1818.

The generic diagnosis for *Aëdes* remains as given in the Monograph (H. D. & K.) with the additions: pronotal and postspiracular setae present; spiracular setae absent; mesonotal setae rarely reduced; wing scales narrow, rarely broad, when broad, the base of the radius, upper surface, has well developed setae.

Genus **Psorophora** Robineau-Desvoidy.

Psorophora Robineau-Desvoidy, Mem. Soc. Hist. Nat. Paris **3:** 412. 1827.

Setal characters of generic significance are: pronotal setae present or absent; spiracular setae present, sometimes small in *Janthinosoma;* postnotal setae present.

Genus **Culiseta** Felt.

Culiseta Felt, N. Y. State Mus. Bull. 79, 391c. 1904.

The presence of a peculiar character, base of subcostal, on lower surface, with distinct pile, makes this a well defined genus. In addition pronotal and spiracular setae (usually only one in *melanurus* Coq.) are present, the post spiraculars absent.

Genus **Orthopodomyia** Theobald.

Orthopodomyia Theobald, Entomologist **37:** 236. 1904.

Pronotals present; spiraculars and post spiraculars absent; prealars usually several, a single stout one in *fascipes* Coquillett; antenna longer than length of proboscis, the joints much longer than broad; fourth tarsal joint of fore tarsus distinctly shorter than fifth joint; wing scales broad, bicolored; base of radius without setae.

Genus **Aëdeomyia** Theobald.

Aëdeomyia Theobald, Journ. Trop. Med. **4:** 235. 1901.

Pronotals present; spiraculars and post spiraculars absent; antenna shorter than length of proboscis, the joints but little broader than long; wings densely scaled, scales broad and tricolored; hind marginal scale fringe longer than width of 2nd anal cell.

Genus **Mansonia** Blanchard.

Mansonia Blanchard, C. R. Soc. Biol. **54:** 1331. 1902.

It is particularly difficult to segregate the species of *Mansonia* as a unit in a key. A good outstanding character or even a combination of characters

common to both sexes and applicable to all species seems lacking in the adult stage.

Pronotals present; spiraculars absent; post spiraculars are present or absent; wing scales broad or fairly broad, bicolored or dark (dark scaled species have post spiracular setae); base of radius (American forms) without setae; the leg setae more developed than is usual with other Culicidae.

Genus **Culex** Linnaeus.

Culex Linnaeus, Syst. Nat., ed. 10, 602. 1758.

Pronotals present; spiraculars and post spiraculars absent; base of radius, upper surface, with setae; mid-mesepimeral setae 0–3; antenna approximating length of proboscis.

The subgenus *Carrollia* Lutz partakes of some of the characteristics of the Sabethini. The abdomen is compressed with patches of brilliantly colored scales; the metanotum may bear setae and the squamal cilia are reduced.

Genus **Lutzia** Theobald.

Lutzia Theobald, Mon. Culic. **3:** 155. 1903.

Lutzia differs from *Culex* mainly by its larger size; numerous mid mesepimeral setae and spotted wings.

Genus **Deinocerites** Theobald.

Deinocerites Theobald, Journ. Trop. Med. **4:** 235. 1901.

The unusually elongate antennae characterizes this genus. Metanotal setae are of sporadic occurrence in certain species.

Tribe URANOTAENINI.

Genus **Uranotaenia** Arribalzaga.

Uranotaenia Arribalzaga. Rev. Mus. de la Plata. **1:** 375. 1892.

This tribe with its single genus is as peculiar in its way as is *Megarhinus*, Megarhinini.

The occiput is densely covered with broad flat scales of metallic colors; the mesonotal setae are well developed and somewhat reduced in number; the pleural setae are prominent but greatly reduced in number, one to two lower propleurals, one lower and one upper prothoracic; one to two pronotals; one spiracular; about two prealars; about five scattered mid sternopleurals; no lower sternopleurals; two upper and one lower mesepimeral; a transverse suture (best seen in slide mount) near upper portion of sternopleura; upper forked cell usually short; anal vein ending opposite or before cubital fork; wings without villi; squamal margins bare; patches of metallic scales on thorax and wings. The palpi are short in both sexes.

Tribe ANOPHELINI.

Genus **Anopheles** Meigen.

Anopheles Meigen, Syst. Beschr. Bek. europ. zweifl. Ins. **1:** 10. 1818.

The scutellum, with its evenly rounded hind margin upon which the setae are evenly distributed, the long palpi of the female and clubbed palpi of the male remain the best diagnostic characters for this group. The American species are more or less naturally divided into two groups by the presence or absence of a tuft of scales on the upper part of the prothoracic lobes. In *A. maculipennis* Mg., however, the tuft of scales may be present or absent.

Subfamily CHAOBORINAE.

A revision of the Chaoborinae, giving subfamily and generic definitions, is given in Ins. Ins. Mens. **12**: 201. 1924 by Dyar and Shannon.

Subfamily DIXINAE.

Delicate midges with long slender legs, without wing- or body scales and with a fringe of delicate hairs on the hind wing margin. Eyes not reniform, nearly circular in outline; antenna sixteen jointed (flagellum fourteen jointed), not plumose; palpi five jointed; proboscis very short; pronotal (proepimeral) setae few and usually near the upper margin; prealar and mesepimeral setae absent; mid and lower sternopleural setae present or absent; mesosternal ridge absent; base of radial sector approximately opposite tip of the subcosta; wing veins bearing small setae; hind wing margin without scales; squamae not ciliated.

Only one genus, *Dixa* Meigen (Syst. Beschr. zweifl. Ins. **1**: 316. 1818, genotype, *maculata* Meigen, ibid.), hitherto recognized.

The larvae of the Dixinae are aquatic; they are easily characterized among the Culicidae by their parallel sided body; absence of airtube; first two abdominal segments each bearing a pair of dorsal pseudopods. The larva remains on the surface of the water at the edge where the capillary film draws up on the margin. When at rest the larva holds itself in a U-shaped fashion.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 14 DECEMBER 19, 1924 No. 21

ZOOLOGY.—*A comparative study of the most ancient and the recent marine faunas.* AUSTIN H. CLARK, U. S. National Museum.

The earliest aquatic fauna that we know, that of the Cambrian rocks, was in its broader aspects singularly similar to the aquatic fauna of the present day. Every one of the numerous component species falls at once within a definite phylum as outlined by recent types, and in a definite class within that phylum. Many of the species can be recognized as members of families still existing, while a few can be assigned even to recent genera.

This can only mean one thing, that as far back as Cambrian time animal evolution, broadly speaking, had already reached the plane it occupies today. In the ages intervening between the Cambrian and the present time the emphasis has shifted back and forth from one type to another within the phyla, classes, or families, leaving the broader aspects of the animal world unchanged.

The variations from horizon to horizon probably result not so much from any evolutionary development of the animals concerned as from physical alterations in environment favoring now one type or subtype, now another. Until the physical and chemical conditions under which the creatures lived and the mechanical stresses they were forced to meet are better understood in relation to animal forms in general it will not be possible to draw any satisfactory evolutionary lines.

In Cambrian times crustaceans were represented by phyllopods, trilobites, and merostomes; among the echinoderms there were crinoids, cystideans, and elasipod holothurians; chætognaths, brachiopods, and graptolites were present; of the annelids we know polynoids, nereids, gephyreans, and *Tomopteris*-like forms; of the mollusks pteropods and gastropods; and there were sea-anemones and other cœlenterates, and sponges.

As a supplement to this varied Cambrian fauna we know from the Ozarkian rocks cephalopods and pelecypods, and from the Ordovician polyzoans, echinoids, brittle-stars, starfishes, and fishes. There is no evidence that these were not also present in the Cambrian.

The significance of this imposing list of Ordovician and pre-Ordovician animals becomes more evident if we contemplate the missing animal types, which are the following: the ctenophores, flatworms and roundworms, rotifers and gastrotrichas, priapulids and sipunculids, heteropods, archiannelid, oligochæte, myzostomid, hirudinid, and onychophorid worms, nemerteans, phronids, insects, pterobranchiates, balanoglossids, tunicates, and vertebrates except for fishes. Other than the insects and the vertebrates, primarily terrestrial, all of these various types are soft bodied creatures which can not reasonably be expected to occur as fossils; they could only be preserved by the merest accident.

Occurring together in the rocks and therefore presumably having lived under approximately identical conditions are phyllopods and trilobites, merostomes, cystideans, and elasipod holothurians, chætognaths, annelids of the *Tomopteris*, polynoid, nereid, and gephyrean types, brachiopods, gastropods, sponges, and sea-anemones. It is scarcely to be doubted that all the other forms also existed under similar conditions.

It is most interesting that of all the numerous types of animals known from Cambrian rocks only a single major type, the graptolites, and two minor types, the trilobites and the cystideans, with the addition of a third, the merostomes, if we can not consider the king-crabs as their recent representatives, have become extinct.

But the numerous types found associated in the Cambrian to Ordovician rocks no longer live together. A segregation has taken place so that now groups of them occur in very definite regions.

All of the recent phyllopods are non-marine, though some occur in very saline water.

Exclusively marine are the pelagic chætognaths and *Tomopteris*-like worms, the abyssal stalked crinoids and elasipod holothurians, the littoral to abyssal echinoids, brittle-stars and starfishes, brachiopods, sea-anemones, cephalopods, and polynoid and gephyrean and practically all nereid worms.

Only the pelecypods, gastropods, sponges, and polyzoans are found both in the sea and in fresh water, and of these only a few groups, more or less distinctive, live in the latter.

In order to explain the segregation of these various types as they are represented at the present day the common features in each group must be first determined. Differences in salinity evidently have nothing to do with it, for phyllopods exist not only in fresh water, but in water with a much higher salinity than the present oceans, though they are never marine. The question of food seem also to be of slight significance, for in the fresh waters of the present day there are vast hordes of insects, obvious intrusions from the land, supported by food of the same nature that in the sea supports a large array of littoral types absent from fresh water.

The exclusively non-marine types are conspicuously feeble; they have a short larval or preadult stage and highly resistent eggs capable of withstanding a wide range of conditions.

The pelagic marine types, relatively large, are poor swimmers, and have a prolonged helpless larval stage.

The exclusively abyssal marine types are weak and fragile, unable to swim, or at least swim well, and have a helpless larval stage.

The animals of the marine littoral extending downward for various depths are either attached or burrowing, or able to cling firmly to other objects; with very few exceptions their young are helpless drifters.

The animals occurring in both fresh water and the sea are attached or burrowing, good crawlers, or good swimmers. They differ from the animals of the marine littoral only in having more varied younger stages, their fresh water representatives lacking a prolonged helpless larval period and developing from origins apparent in the marine types various peculiarities, enabling them to travel or to be carried overland.

To put this in another way, of the various types of animals represented in the Cambrian to Ordovician seas only those which live attached, or burrow in the mud, or are good crawlers or swimmers, and in addition have adaptable larval stages or asexual methods of reproduction, have been able to maintain themselves in the sea and also in fresh waters. Helpless drifting young prevent animals of medium or of large size from persisting in fresh water, though in the sea they may occur from the littoral to the abysses. If the adults are also helpless drifters, a pelagic marine life is the only kind of existence possible at present. If the adults are feeble bottom livers, they can only occur in the abysses. If the adults are feeble but the young are capable of transportation overland, they can exist in fresh water in temporary pools or elsewhere where they will be safe from their enemies.

The segregation at the present time of the numerous types found living all together in the Cambrian thus seems to be dependent on certain physical factors which differentiate the sea from ponds and lakes and rivers.

The most important one is size. The present bodies of still fresh water are too small to support large and slow breeding drifting animals with helpless drifting young, and therefore also such animals as feed on these. The larger ponds and lakes abound in plankton, but the planktonic animals are all small to minute, and rapid breeders.

Contrasting the present with the past we see in Cambrian rocks living apparently as littoral types various weak and feeble animals now confined to those regions of the sea where no motion of the waves exists. This suggests in Cambrian times the absence of a surf line on the shores, or at any rate absence of such gales and storms as are frequent at the present day.

It is possible to explain the shrinkage of the epicontinental seas and the appearance of a surf barrier in terms of the assumed difference between the Cambrian and the recent seas.

The evidence seems conclusive that in the past the seas were much less salt than at the present day. All through the ages the water from the rains percolating through the ground and collecting in rivers running to the sea has been carrying to the latter the salts which it has taken from the land, while in its evaporation from the surface of the sea to fall again upon the land as rain it has left the salts behind.

Undoubtedly there have been from time to time considerable additions to the amount of water on the surface of the earth; but, generally speaking, there is no reason for supposing that the sea has not been gradually increasing in salinity throughout the ages.

An increase in the amount of salts dissolved in water diminishes the vapor pressure. Thus the saltier the sea the less will be the evaporation from its surface, and hence the greater the proportion of the earth's water held permanently in the ocean basins as compared to the water in the lakes and ponds and rivers, and to the water vapor in the air.

If the present oceans were of fresh water their surface would be far below the present level, and numerous land connections would appear by which a general interchange of faunas now unconnected would be possible.

This water taken from the sea would greatly increase the lake and marsh areas on the land, and at the same time result in more or less extensively blanketing the earth with clouds. An extensive envelope of clouds about the earth would have two most important consequences. In the first place the sun's heat would be far more equably distributed. There would be no frigid poles nor superheated tropic zone. Hot and cold regions would be small and localized, and would occur only where the sun shone through the clouds. In the second place, an equality of temperature on the earth's surface, or even a fair approximation to it, coupled with fresh water seas, would mean a minimum of atmospheric circulation, and a general state of calm unbroken by storms such as we know today. Wave action would be very slight and there would be no destructive surf line. Ocean currents would be very slow.

The difference between the fauna of the oldest rocks and the fauna of the recent seas on close examination seems to be not so much a real difference in the animal types themselves as an apparent difference resulting from (1) more extensive land connections; (2) more equable distribution of the sun's heat; (3) more tranquil conditions, on land and in the sea; and (4) more extensive epicontinental waters.

These four factors are capable of very simple explanation, in large part if not indeed entirely, on the basis of the ever increasing saltiness of the sea.

BOTANY.—Pseudochaetochloa, *a new genus of grasses from Australia.* A. S. Hitchcock, U. S. Department of Agriculture.

Recently a fine collection of grasses was received from Mr. W. M. Carne, botanist of the Department of Agriculture of Western Australia. The plants were collected mostly in western and northwestern Australia. Many species were not previously represented in the National Herbarium. Among the specimens was one which could not be identified with any described species and possessed characters which did not agree with those of any genus as now delimited. It appears best to recognize the species as the type of a new genus rather than extend the characters of *Chaetochloa* (*Setaria*), to which it is allied. In *Chaetochloa*, a large genus of Paniceae, found in all the warmer regions of the earth, the spikelet is in the main like that of *Panicum*, but the inflorescence is interspersed with sterile branches or bristles. The fertile floret in *Chaetochloa*, *Panicum*, and their relatives, is indurate, differing distinctly from the sterile floret with its membranaceous nerved lemma, and the palea

is enclosed all around the edges by the inturned margin of the fertile lemma. Thus the fertile floret is a little box enclosing the caryopsis, and this box does not open even in germination, the base of the plantlet pushing its way through the lower part of the box.

In *Pennisetum* the fertile floret is like the sterile and the palea is not tightly enclosed. In *Pennisetum* and *Cenchrus* there are sterile branches in the inflorescence but these are gathered in a cluster below each spikelet or group of spikelets. In *Cenchrus* the whole cluster forms a bur (sandbur) and is deciduous from the main axis. In *Pennisetum* the cluster is also deciduous but is too soft to be called a bur. In the new genus described below the bristles are as in *Chaetochloa* but the spikelet is as in *Pennisetum*. But the whole branch is deciduous from the main axis.

Pseudochaetochloa Hitchc., gen. nov.

Spikelets as in *Panicum*, 2-flowered, the lower floret sterile but well developed; sterile and fertile lemmas membranaceous, similar in size, shape, and texture, acute; a single bristle subtending many of the spikelets as in *Chaetochloa*.

Type species, *P. australiensis* Hitchc.

Pseudochaetochloa australiensis Hitchc., sp. nov.

Perennial; culms erect from a decumbent base, glabrous, slightly scabrous below the panicle, 40 to 60 cm. tall; sheaths glabrous; ligule a dense ring of hairs about 1 mm. long; blades narrow, erect, those of the innovations scaberulous, involute, filiform, 15 to 25 cm. long, flexuous, those of the culm flat, as much as 4 mm. wide, scaberulous, narrowed at base, attenuate at apex, as much as 25 cm. long; panicle erect, narrow, rather dense, about 10 cm. long, the axis scabrous; branches as much as 1 cm. long, deflexed at maturity and finally deciduous from the main axis; pedicels mostly less than 1 mm. long, the branchlets bearing below some of the spikelets a splender, antrorsely scaberulous bristle 2 to 5 mm. long; spikelets 5 to 6 mm. long, pale, glabrous, lanceolate; first glume 2 mm. long, obtuse, 3-nerved; second glume about 2.5 mm. long, acutish, 3-nerved; sterile lemma membranaceous like the glumes, acuminate, 5-nerved, the palea nearly as long; fertile lemma similar to the sterile, slightly longer, slightly more pointed, 5-nerved, the palea nearly as long.

Type in the U. S. National Herbarium, no. 1,172,752, collected at Devil's Pass, Napier Range, Kimberley Division, Western Australia, May, 1905, by W. V. Fitzgerald (no. 600).

The plant has the aspect of a species of *Chaetochloa*. The only specimen seen is rather meager, having only two panicles, one young, the other mature but with spikelets only on the lower half, the branches having been shed from the upper part of the axis.

In the spikelets examined no stamens were found in the sterile floret but the well-developed palea would indicate that this floret may be normally staminate.

CULTURAL ANTHROPOLOGY.—*The factor of difference.* JOHN R. SWANTON, Bureau of American Ethnology.

At the present time our evolution-dominated anthropological and biological studies invariably emphasize resemblances. In tracing the evolution of a cultural object or an animal or plant organism those factors are first enumerated which agree, the impression being left in the reader's mind that object or organism *b* is simply *a*, plus a disturbing element too small to require much consideration. In discussing organic evolution similar factors in *a* and *b* are first treated, then the apparently unimportant changes called fluctuations, then Mendelian characters derived from ancestral forms, and, last of all, mutations, which, when positive, involve the introduction of factors entirely new. Since this method of approach is from the known to the unknown, it is justified on general scientific principles, but in the monotonous repetition of this one method there is a tendency to throw the student's view of the entire subject out of focus. Differences between two objects or organisms in a series are minimized to such an extent that one is apt to forget that, however slight such differences appear to be, were it not for them there would be no evolution.

Under such conditions, it is well worth one's while to try the experiment of an exactly contrary approach. In the first place is the outstanding fact just noted that without mutations, or their equivalent, there would have been no evolution, and if from an evolutionary series we take away progressively each mutation we have nothing left at the end except the inorganic basis. In other words, any organism is equivalent to the sum of past mutations. This does not mean that organisms not separated by recognizable mutations are therefore identical in every respect except the possession of distinct individualities. Evidence rather points to the conclusion that no two organisms are ever precisely alike. Probably if they were precisely alike there would be no distinction of individuality. Leo Loeb says:

"We must assume that every individual of a certain species differs in a definite chemical way from every other of that species, and that in its chemical constitution an animal of one species differs still more from an animal of another. Every cell of the body has a chemical character in common with every other cell of that body and also in common with the body fluids; and this particular chemical group differs from that of every other individual of the species and to a still greater degree from that of any individual of another group or species.

"It has been possible to demonstrate by experimental methods that there are fine chemical differences not only between different species and between different individuals of the same species, but also between different sets of families which constitute a strain, for certain chemical characters differentiate them from other strains of the same species. It has been shown, for instance, that white mice bred in Europe differ chemically from white mice bred in America, although the appearance of both strains may be identical."[1]

More might be quoted to the same effect, but, indeed, the most striking proof of this is one which any reader may apply himself. Among human beings father and son or mother and daughter may resemble each other so closely that a comparative anatomist would find an almost perfect part for part correspondence between them; in the case of "identical" twins resemblances are still more striking. Yet this does not prevent each of the two individuals concerned from having a feeling of absolute independence, from living his or her own life with entire disregard of the life of the other, and even allowing the very existence of the other to drop wholly out of mind.

Osborn denominates[2] as saltations major, suddenly introduced changes between organisms. But there appears to be no sharp line of division between a change so denominated and all other changes from one organism to another. Why, then, might we not extend the term saltation to include all changes since all do in fact appear suddenly with the birth and growth of each separate organism? Instead of viewing evolution as a process which is mainly continuous but varied by occasional mutations or saltations, we might regard it as a series of saltations linked together and in some measure determined genetically.

This may also be aligned with the fact that the basal, inorganic world is atomic and not absolutely continuous. Having resolved matter into molecules and then into atoms, science has in recent years gone beyond and resolved atoms into electrons. Precedent would suggest, therefore, that if further resolution is accomplished it will again be into certain definite entities and not into a continuum.

If there is a real utility in looking at plant and animal life from the point of view of their differences, it becomes more pronounced when we consider anthropology in its cultural aspects, a consideration to which the preceding discussion is merely preliminary. Prof. E. B. Tylor, "the father of anthropology," speaks of cultural evolution thus:

[1] Scientific Monthly. 3: 209–226. 1916; quoted in Osborn, *The origin and evolution of life*, p. 252. New York, 1917.

[2] *The origin and the evolution of life*, pp. 140, 252.

"It being shown that the details of culture are capable of being classified in a great number of ethnographic groups of arts, beliefs, customs, and the rest, the consideration comes next how far the facts arranged in these groups are produced by evolution from one another. It need hardly be pointed out that the groups in question, though held together each by a common character, are by no means accurately defined. To take up again the natural history illustration, it may be said that they are species which tend to run widely into varieties. And when it comes to the question what relation some of these groups bear to others, it is plain that the student of the habits of mankind has a great advantage over the student of the species of plants and animals. Among naturalists it is an open question whether a theory of development from species to species is a record of transitions which actually took place, or a mere ideal scheme serviceable in the classification of species whose origin was really independent. But among ethnographers there is no such question as to the possibility of species of implements or habits or beliefs being developed one out of another, for development in culture is recognized by our most familiar knowledge. Mechanical invention supplies apt examples of the kind of development which affects civilization at large. In the history of firearms, the clumsy wheel-lock, in which a notched steel wheel was turned by a handle against the flint till a spark caught the priming, led to the invention of the more serviceable flint-lock, of which a few still hang in the kitchens of our farm-houses, for the boys to shoot small birds with at Christmas; the flint-lock in time passed by an obvious modification into the percussion-lock, which is just now changing its old-fashioned arrangement to be adapted from muzzle-loading to breech-loading. The mediaeval astrolabe passed into the quadrant, now discarded in its turn by the seaman, who uses the more delicate sextant, and so it is through the history of one art and instrument after another."[3]

Tylor thus draws the closest parallel between cultural evolution and biological evolution and congratulates the student of the former on the greater certainty with which his evolutionary threads may be followed. However, there is one important difference to be noted between the two, viz. that biological evolution is an evolution in organisms, or at least in characters associated with organisms, while cultural evolution is an evolution in ideas or concepts. To take the instances cited by Tylor himself, the wheel-lock gun did not literally give birth to the flint-lock, the flint-lock to the percussion-lock, and the latter to the breech-loader. The astrolabe did not give birth to the quadrant and the quadrant to the sextant. Each is an arrangement of materials placed in a particular form not by any power which it itself possesses but by the human mind.

It is not necessary even that there should be biological succession on the part of the inventors, for while different inventions in a series have usually originated with distinct individuals separated somewhat from each other in time, it is quite possible, as sometimes happens,

[3] E. B. TYLOR: *Primitive culture* 1: 14-15. New York, 1877.

that one mind should give birth successively to a number of inventions in the same series.

A given concept e may be explained in one of three ways: (1) as the sum of preëxisting concepts a, b, c, d; (2) as preëxisting concepts plus some new element x; or (3) as an entirely new element, i.e., identical with x.

The first explanation, which may be expressed in the form

$$a + b + c + d = e,$$

is at least not of universal application because in progressive evolutionary series entirely new elements make their appearance. In the examples cited by Tylor the wheel-lock gun, the percussion-lock gun, the flint-lock gun, the astrolabe, quadrant, and sextant contain such novel elements. That the substances in which they were objectively expressed and the physical and mechanical laws observed in making them were already in existence does not enter into the argument, for if we take the ground that nothing is to be considered new that has already existed in potency, nothing is new and our whole discussion is fruitless.

The second hypothesis as to the origin or e mav be shown thus:

$$a + b + c + d + x = e.$$

Of course a, b, c, and d are merely samples of the indefinite number of concepts that may have entered into or paved the way to x. But, after all, is it correct to speak of a, b, c, d, etc. as entering into e? We know that the *object* to which e corresponds contains elements to which those earlier concepts gave birth, but that is not the same as saying that those concepts enter into the present one. For one thing, we know that e may be reached in a number of different ways, sometimes through an independent series of concepts, a', b', c', d', while sometimes they may be entertained in a different order, as a, c, b, d, etc. This view is also strengthened by the consideration that when we explain an object to another in order "to communicate the conception" to him we do not ordinarily lead his mind over the course pursued by the minds which produced it but explain it to him as a present unit. Even if we concede that concept e is compound we must at the same time admit that the element which gives it independent existence, the soul of it, so to speak, is the new factor x. And though there appears to be a concept composed entirely of preëxisting concepts, one to which the formula $a + b + c + d = e$

might seem to apply, we discover that in the device of bringing these several elements together we actually have a new factor, and therefore our argument extends to such cases also.

Therefore, since each concept in an evolutionary series, either as a whole or as to its essential feature, is independent of every other, the factor of difference in cultural evolution is of the first importance, more important if anything than in biology.

The cause of this is not far to seek and may readily be explained by consideration of a single simple custom of every day experience, the removal of the hat as a token of reverence or respect. Tylor suggests that this item of etiquette originated with mediaeval knights who were wont to take off their helmets in similar situations. Perhaps this explains why we perform that particular act *rather than some other*, but it does not explain why we perform the act. We perform the act from a feeling of reverence or respect, or because we desire it thought that we entertain reverence or respect. If one were to say that he removes his hat because his ancestor took off his helmet, he might equally well affirm that he rides in an automobile because his ancestor traveled on a sledge, that he crosses bodies of water in plank boats because his ancestor crossed them on logs, that he makes sketches, has laws, constitutions, and religious beliefs because his ancestor performed similar acts or had similar institutions and ideas. Indeed, to follow the thought of certain early anthropologists like Herbert Spencer, one might suppose that man lived for the sole purpose of imitating his ancestors.

Every concept, whether it involves something wholly new or follows closely a preceding concept, is the expression of a present desire; it is the child, not merely of its own age but of its own moment, and the original element which it contains is that which is most characteristic of it. It uses the material which it finds "ready to hand," the preëxisting concepts, to assist its expression but essentially it is—however abhorrent the words to scientific ears—a "special creation." Possibly it is worth considering whether something similar might not be said of the organisms and characters which, in biology, correspond to cultural concepts.

SCIENTIFIC NOTES AND NEWS

Dr. ALFRED HULSE BROOKS, Chief Alaskan Geologist of the U. S. Geological Survey, died at Washington Nov. 22.

Dr. Brooks was born at Ann Arbor, Mich., July 18, 1871. His boyhood was spent in Newburgh, N. Y., where he received his early education at a private school. He early acquired a taste for geology from his father, Thomas Benton Brooks, noted mining engineer and State Geologist of Michigan, and went abroad to study at Stuttgart and Munich, Germany, before he was graduated at Harvard University in 1894. Later he took post-graduate studies at the University of Paris. He has since received the honorary degree of doctor of science from Colgate University.

He was appointed assistant geologist in the U. S. Geological Survey in 1894, having spent several preceding seasons in temporary field work in the Appalachians and in Michigan under Professor Pumpelly and others. In 1898 he began work in Alaska and in 1903 was appointed geologist in charge of the Division of Alaskan Mineral Resources. In 1911 he was appointed vice chairman of the Alaskan Railway Commission. During the World War he served in France as Lieutenant Colonel and Chief Geologist of the A. E. F. He was later attached to the Peace Commission in its investigation of the resources of the Central Powers. He has been awarded the Malte-Brun gold medal of the Geographical Society of France and the Daly gold medal of the American Geographical Society.

Dr. Brooks was president of the Geological Society of Washington in 1911 and president of the Washington Academy of Sciences in 1921. He was also a member of the Geological Society of America, Association of American Geographers, American Association for the Advancement of Science, Mining and Metallurgical Society, American Institute of Mining Engineers, Société Belge de Geologie, Explorers' Club, and National Geographic Society. He was the author of many important papers on Alaskan geography and geology and on other geologic subjects.

Dr. ALEXANDER WETMORE, biologist in the Biological Survey, has been appointed Superintendent of the National Zoological Park, succeeding NED HOLLISTER, who died recently. During his connection with the Survey Dr. Wetmore conducted numerous investigations in ornithology and mammalogy, directing, in 1923, the U. S. S. "Tanager" expedition in general scientific exploration of islands of the Pacific.

The Petrologists' Club met at the home of F. E. WRIGHT on November 18. *Program:* L. H. ADAMS, *Temperatures at moderate depths within the Earth;* H. S. WASHINGTON, *Chemical composition of the Earth as a whole;* C. S. ROSS and E. V. SHANNON, *Bentonite and related minerals.*

Mr. H. T. EDWARDS, of the office of Fiber Plant Investigations in the Bureau of Plant Industry, sailed from San Francisco, November 29, for Manila, where he will be engaged during the next six months, in cooperation with the Philippine Bureau of Agriculture, in encouraging the more general use of improved methods in producing, cleaning, and packing abacá, maguey, and sisal.

Dr. N. H. DARTON, of the U. S. Geological Survey, has returned to Washington after a two months trip to determine the geologic history of the ruins of the archaic temple of Cuicuilco in the Pedregal lava 12 miles south of Mexico City. The investigation was made under the auspices of the National Geographic Society, which is cooperating with the Mexican Government in excavating the ruins.

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23.2.45		
2-1-63		